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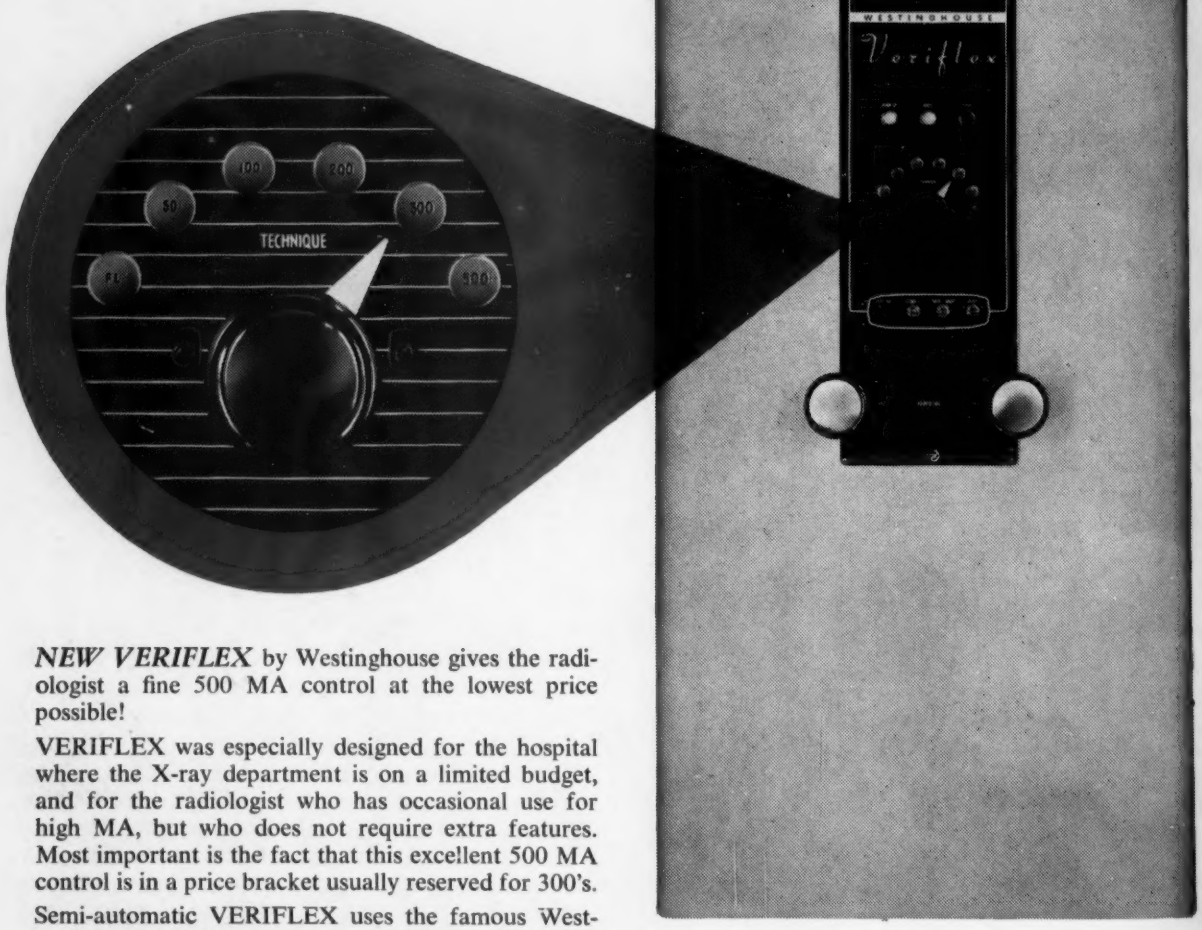

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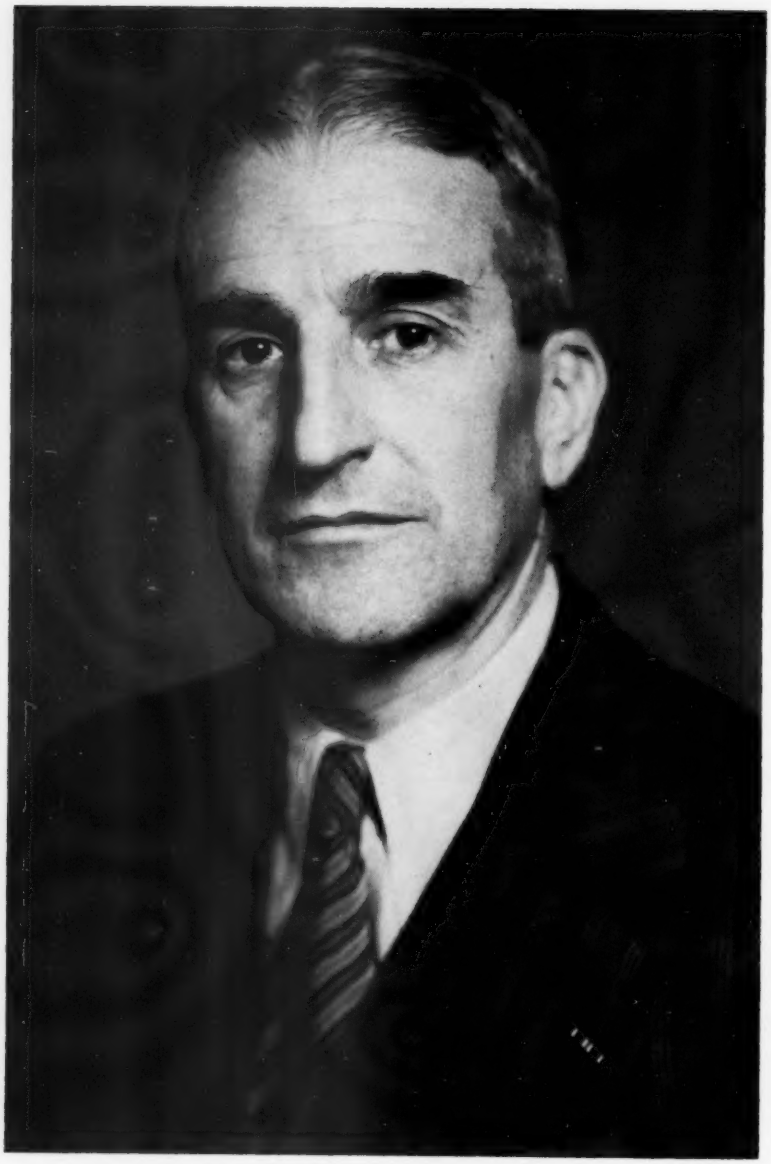

LAURISTON S. TAYLOR

Janeway Lecturer, 1954

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EDUCATION IN RADIATION PROTECTION

JANEWAY LECTURE, 1954*

By LAURISTON S. TAYLOR
Atomic and Radiation Physics Division, National Bureau of Standards
WASHINGTON, D. C.

IN SEEKING an appropriate subject for presentation in memory of Dr. Henry Harrington Janeway the choice was to a considerable extent based upon finding a topic of current interest and at the same time one with which the author has had extended experience. The problem of radiation protection fits into both requirements. With the present-day impact of radiation upon the lives of all of us, it is becoming increasingly important that some knowledge of protection against its effects be broadly disseminated to the radiologist, non-radiologist physician, and layman alike. Of necessity this requires that some degree of educational effort be directed to all of these groups.

The problem of protecting persons from the harmful effects of radiation (roentgen rays, gamma rays, beta rays, alpha rays, neutrons, etc.) has been existent since their first discovery. In the early days of gas tubes, protective measures were almost non-existent, but the problem was limited in scope and magnitude mainly because the equipment was not in such widespread use. During the period of World War I the use of roentgen-ray equipment expanded rapidly through the introduction of the Coolidge tube, and an alarming increase in radiation burns was noted. This resulted in prompt and relatively effective measures being developed to cope with the problem.

Until about 1925 the principal uses of radiation were in the medical field. From then on the industrial use began to increase rapidly and at the same time higher and higher energies were developed for use in medicine, industry, and research. Until about 1943 harmful effects of radiation were limited to the patient, doctor, technician or industrial worker. It could scarcely be regarded as a public health problem, though it was beginning to become an industrial or occupational health problem.

Following the advent of atomic energy, radiation from radioactive sources began to be developed in quantity, variety and dis-

* The nineteenth Janeway Lecture, delivered at the Thirty-sixth Annual Meeting of the American Radium Society, Hot Springs, Virginia, March 14–16, 1954.

tribution in magnitudes never before dreamed of. It quickly became clear that within a very few years radiation protection had become a serious problem not only as an occupational health problem but as a widespread public health problem, and was recognized as such. An additional problem, recently developed, has been more of a psychological nature. In large measure due to the public press, the lay population has often developed an exaggerated notion of the seriousness of the problem which has, at times, resulted in almost panicky efforts to eliminate or reduce it.

It is difficult to make a clear distinction between education and training and in this discussion the terms will be used more or less synonymously. Dr. Ross Golden,[1] in an address before the American College of Radiology in 1944, discussed the differences between the two in relation to "Medical Education" and "Training in Radiology" and his words are well worth reading. There is further concern about how properly to delimit the broad question of radiation protection and its relationship to education. The breadth of the problem has been well expressed by Herbert Spencer, who said that "To prepare us for complete living is the function which education has to discharge."

A discussion of education in radiation protection should start perhaps with the tacit assumption that the necessity for radiation protection is clearly recognized by all—except that this would not be borne out by the facts. Unfortunately, too many experienced radiologists agreeing to the principles apparently neglect protective measures in their personal practice. Not a great many, but too many, will argue that observance of all the precautions available to them will impede their work and that their mission necessitates some calculated risks. It may be argued that there are enough normal risks, and only rarely is an avoidable risk anything but just plain foolhardy.

Today we can operate under the assumption that a high degree of protection from radiation can be achieved—and achieved by the radiologists themselves, and they may rest assured that if they do not do it someone else, probably less experienced, will try to do it for them.

There is increasing evidence of a growing tendency to try to solve our problems by legislative means rather than by education.[2] Any overzealousness for radiation control legislation can be kept within bounds only if the radiologist's own house is in good order. If only for that reason alone, it is becoming more important daily that our younger radiologists be educated in the general philosophies and principles of radiation protection. Only a few of these will be touched upon.

The primary aim of radiation protection is to avoid radiation injury without impeding the desirable and necessary uses of radiation. Total protection can rarely be achieved without some real or potential sacrifice in utility or flexibility, but with thought and experience a compromise can be realized. Surely the radiologist does not want to sit in a lead box and palpate the patient's abdomen with a remote control robot or "slave" and look at the results on a television screen. No more does he want (it is hoped) to sit unprotected next to the fluoroscope and palpate for hours on end with his bare hands. Common sense must find a workable ground between. This common sense can be assisted materially with some broad technical knowledge, much of which can be obtained from available textbooks and the handbooks of the National Committee on Radiation Protection. It is not necessary for the student or the radiologist to learn a vast number of technical details, data, and computational methods. It is necessary, however, for him to learn where the information can be found, and how to use it when he finds it. It is even more necessary for him to know when he needs it.

[1] President's Address. *Bull. Am. Coll. Radiol.*, 1944, pp. 19–30.

[2] Taylor, L. S. State control of protection against ionizing radiation. AM. J. ROENTGENOL., RAD. THERAPY & NUCLEAR MED., 1954, *71*, 691–702.

This brings to mind a statement made by the head of an electrical engineering department in a university to the effect that he would be satisfied, if, upon graduation, an engineer simply knew when and how to make intelligent use of the Standard Electrical Engineers Handbook. The same principle applies to the young radiologist except that unfortunately there is no one handbook that gives all the necessary information and data. However, an adequate protection library consists of relatively few books and pamphlets and should be available to all radiologists.

It is not easy to outline a curriculum for a course of education in radiation protection and no attempt will be made to do so. On the other hand, mention will be made of a few broad areas that should be included. The radiologist's responsibility in radiation protection goes far beyond his own little area of occupation—he has, in fact, an obligation to society in general, and to those charged with our public health and safety in particular. At the local level he is responsible for the safety of his own operations, the operations of his employees, and possibly others in the same hospital. In addition he, in turn, must accept his duties as a teacher of younger men. But before he can do any of these successfully, he himself must be taught.

EDUCATION OF THE PUBLIC

Education in radiation protection is taking on a broader significance as the public beomes increasingly conscious of the existence of radiation and its potential dangers. Scarcely a day goes by without mention in the press or radio of atomic weapons, "atomic cocktails," or some new radiating device made possible through the release of atomic energy. The production of all manner of radioactive materials has indeed introduced all manner of new problems, the solutions to many of which are being rapidly found. But at the same time the general public, through half-knowledge, is acquiring ideas about radiation some of which are healthy and others of which are based solely on fear, misunderstanding, and apprehension.

Today the radiologist must not only learn the science of protection but he must also learn to put the problem of protection into proper perspective with relation to society. There is urgent need of some therapy to treat the public's attack of radiation psychosis. The man of the street is no longer content to be talked down to and simply told that he needn't worry about radiation. He knows he will need to worry about it in the event of an atomic attack and he is not sure but what he ought to do just a little worrying anyway on general principles. In the last analysis the radiologist is to have a key role in this national problem. Some of the more technical aspects will be handled by the radiological physicist, but after all, the big problem is essentially medical in nature.

Up to the present time the radiologist has not fully demonstrated his role of leadership in this area; in fact, probably no more than a few even recognize it. This, then, is a point upon which some degree of educational effort must be spent. There are no textbooks or curricula available on the subject. Indeed, it is difficult to recommend a start except to suggest that the problem be brought to the attention of our younger men, and that they start to think of the problem and thereby gradually develop a consciousness of their public duty in this respect.

CLINICAL ASPECTS OF RADIATION PROTECTION

Naturally, the most common area in which radiation protection experience is acquired is in the clinical or office practice of radiology. The clinic is the proving ground not only for the radiologist but for the practical application of most of the essential features of radiation protection. Even the basic pattern for industrial radiation protection is largely the result of radiomedical experience and practice. (It is largely for this reason that the National Committee on Radiation Protection has laid primary emphasis on medical and

radiobiological practice, for once the protection problems in these areas are in order, the shift in application to industry is mainly a matter of deatil.)

Let us look briefly at some of the educational and training requirements designed to take maximum advantage of our present knowledge of radiation.

The young radiologist should be educated in the background and significance of permissible dosage or exposures and should at all times retain a sense of proportion and a sense of humor relative thereto. For example, the present permissible exposure for the whole body is 300 milliroentgens per week (measured in air). This figure was determined from a limited amount of clinical and biological data to which was applied a series of well educated guesses, and yet we may find a person's weekly exposure recorded as, say 163 milliroentgens—a figure that few, if any, practical clinical instruments can measure with an accuracy of better than ±10 per cent. Again, if a film badge (accuracy ±20 per cent) shows a reading of 260 milliroentgens for one week are we to be alarmed? And are we to be complacent with a duplicate reading of 200 milliroentgens taken in the same place for the same week? Actually both readings are the same within experimental limits of error and we should be alarmed in both cases not primarily because the readings differ but because the exposure in each situation may be unnecessarily high. It is only rarely that working conditions at a radiation level far below the permissible dosage cannot be obtained with but little inconvenience or added expense.

The aim should be to see how low a practical operating level can be achieved—not how high a level without transgressing the 300 mr per week medicolegal upper limits set by radiation safety experts. Even the smallest amount of radiation has some effect on the living human body. Even if the harm is normally undetectable by the individual, genetic damage can result from single minute exposures. We must prevent perceptible harm or damage—we should minimize the likelihood of undetectable damage even though we cannot eliminate it entirely.

Physical measurements of radiation provide our only guide to exposure and so one must become accustomed to see and use the numerical values that go along with them. We must religiously adhere to the magic numbers for they are our only common language. The fact that the radiation level in a given work area is, say, 100 mr per week (one-third the permissible level) must be taken as gospel even though we know perfectly well that it probably does not tell us within a factor of 2 what dose the individual in the area will receive in his critical organs or tissue. If it is 100 mr per week we should strive to reduce it to 50; if it is 50 we should try to get it down to 25. In other words, we should act safe and play safe and be continually on the lookout for ways and means to further reduce any exposure no matter what the level. The only balance required in this procedure is to insure that at the same time the effective use of the radiation is not unduly impaired. This is one of the most basic points of philosophy that should be instilled into the trainee. At the same time it must be realized that the problem is not capable of a straightforward solution.

Another essential point of education has to do with the radiologist's responsibility to himself and others around him in matters of radiation exposure. The radiologist has a sacred duty to protect his patients, his staff and assistants, the outsiders who may be visiting physicians, or the occupants of the apartment next door, and last, but by no means least, himself. All of these may involve different protection or shielding situations. Each new situation should be carefully studied and in most cases exploratory radiation measurements made, either to determine that no hazard exists or to obtain quantitative data on the magnitude of the hazard if it does exist. Nothing should be taken for granted. Protection of a patient from stray radiation is often consciously neglected on the premise that he is getting so much anyway that a little more will not

matter. This sort of careless thinking is to be avoided. There is no justification for permitting any avoidable stray radiation to reach, say, the gonads during a chest roentgenogram. On the other hand, for a patient receiving massive deep radiation therapy in the pelvic region, there is no need to reduce the stray radiation to the chest below, say, 1 per cent of the direct radiation.

Protection of one's staff and of professional visitors is partly a matter of physical shielding but more especially a problem of correct education, training and work habits. This is the responsibility of the radiologist. Particularly for some of the more routine roentgenographic operations, the radiologist must be constantly alert to the procedures and operating position of the technicians, and in addition he must develop their proper consciousness of radiation hazard. Their exposures should be checked by actual measurements—dosimeter or film badge or both. It can be very helpful to demonstrate the actual exposure under conditions that are known to be bad.

Protection of the outsider when he is literally outside is normally a matter of permanent shielding and any given situation can be readily evaluated. But when the outsider is inside it may be more difficult. The guest physician who wants to peer slantwise at the fluorescent screen may stand in a position where he will receive a large dose of radiation scattered from the patient. More often than not he will consider that he is exposed only occasionally and hence will not want to bother with an apron. More serious is the tendency of, say, the orthopedic surgeon to neglect exposure in the interest of possibly more expeditious setting or surgical operations. It is the radiologist's duty to evaluate the exposure and risk and to work with the surgeon toward the development of means and techniques for minimizing them.

And then there is the radiologist himself. Pressure of work, enthusiasm for his task, desire to do the most for his patient, and sometimes a martyr's attitude, all contribute their bit to his downfall. It is of course well recognized that in fluoroscopy the radiologist may easily be bathed in scattered radiation from the patient. Much of this can be avoided if the doctor will permit it. Simple things like lead rubber aprons fastened to the screen in horizontal fluoroscopy can be a great boon, yet they are often resisted because of the feeling that they will sometimes get in the way, or make screen motion more difficult because of the added weight. Possibly this is true but with a little thought and training these difficulties can often be overcome. The wearing of protective gloves and aprons is often resisted for similar reasons, or loss of "touch." Some radiologists wear only kid gloves in order to retain as much sense of touch as possible. But they are only kidding themselves; kid gloves are better than no gloves at all—but not very much better. The argument put forward for this is that secondary beta rays and very soft roentgen rays are the primary source of damage, whereas, in fact, the hands are pretty well bathed in penetrating radiation.

And what has all this to do with the early education of the radiologist? In my opinion, it has a great deal to do with it. Only a few commonplace things have been mentioned, yet they are samples of the ideas that must be drummed into the radiologist, at the outset of his career, in a manner so forceful and clear that he will remain forever conscious of them.

A start would be made by developing a balanced understanding of the problem in his own little domain—by making him realize that virtually any degree of protection is obtainable but that there is a practical and commonsense limit. This, of course, does not mean the provision of marginal protection—on the contrary, as mentioned above, radiation exposure should be reduced to the lowest practical level. The aim of educational effort early in a man's training should be to produce a constant vigilance without making it a fetish.

A good sign to have in the radiation room might consist of two words,

"Radiation—Think"

INSTRUCTION IN RADIATION PROTECTION PROCEDURES

Methods of instruction in radiation protection should be given careful thought. The radiologist in training cannot afford to spend a large fraction of his time studying protection, nor indeed would this evidence the sense of proportion we want to develop. "Book learning" is necessary of course. As pointed out elsewhere, the basic elements of protection are available in numerous texts and handbooks, but few if any of these dwell at any length on the problem of improving the safety of routine operations. Most of these sources give shielding data, tell how to make shielding computations, and give a number of rules as to what to do or not to do—but fail to tell how to do many of these things.

Take, for example, the preparation of radium or cobalt-60 applicators. Much of the technique here will be learned from watching older and more experienced men and then starting to practice with "live ammunition." As nearly as can be determined, initial practice in the form of dummy runs is relatively rare. Yet this requires almost no special equipment beyond some brass slugs to represent the active sources. If provision for this sort of practice rehearsal were made, time-and-motion studies could be carried out under supervision, with the trainee repeating the operation until it goes smoothly and quickly. Finally, when the active sources were used, it would be desirable to carry out at least a few runs while at the same time measuring the exposure to the hands, arms, body, etc., by means of film badges or dosimeters. Such practical experimental experience may be compared with dissection in medical school. One could read every book written on anatomy but would never know the subject without having taken a body apart.

Similar education and training in the handling of radioactive solutions is even more essential because accidents can happen more easily and a situation can get out of control much more quickly than with sealed sources. Handling may require many unusual operations; unpacking a lead pig with long tongs, removing a bottle stopper without touching it, pipetting by bulb rather than mouth, working with a barrier in front of the material, using mirrors that reverse the image, and making all movements such that a spill would be contained and so on. Here time-and-motion study and practice is essential. In cases where the operating personnel have had little experience in such matters, it has often been demonstrated that remote handling and the interposition of barriers can actually be so awkward that the resultant slow-up of an operation nets a larger exposure than would be obtained by fast and accurate operations with much less shielding.

Handling practice should start in school, continue in training and finally become a part of the established practice in clinical operations. Again, the facilities for dummy runs are almost negligible. The radiologist should not only master the handling problems himself, but it is his duty and responsibility to teach his technicians and assistants the habits of skill and safety. He has an equal responsibility for weeding out individuals who, after reasonable practice and experience, show a lack of appreciation of the problem or of the attitude necessary for carrying out all operations safely.

Unfortunately, the training facilities in isotope handling are rather limited at present, although this is being remedied rapidly. Some of the larger radiological teaching and training centers are developing laboratory training such as mentioned above, but this is by no means as widespread as it should be. In addition, field workers from the Atomic Energy Commission Isotope Division are rendering an invaluable instruction service in the smaller centers all over the country.

An additional means of disseminating such information on a qualitative basis is through the use of educational motion pictures or strip films and voice recordings. Apparently nothing of this kind has been prepared in the radiological field. The

American Dental Association in cooperation with the National Bureau of Standards has prepared a radiation protection film and the initial cost was not very great.

One of the most widely used radiation sources is the fluoroscope—it is also potentially one of the most hazardous. Rules and recommendations for shielding are available, but not too much has been written on methods of practice. Handbook 41 of the National Committee on Radiation Protection points up the necessity for the lead glass in a screen overlapping the fringes of the largest possible beam. It also urges using the smallest fields possible. Every radiologist knows these things, but from limited observation of current practice it may be estimated that not over 5 per cent of them have checked the screen and not over 25 per cent bother to cut down the field—except to cut down glare.

In many situations it is desirable to stand obliquely to one side of the field in horizontal fluoroscopy in order to avoid the maximum of scattered radiation from the patient. On the other hand, possible gains may be offset by inconvenience and awkwardness that result in prolonging the exposure. Furthermore, additional exposure may result from leakage radiation through the Bucky slot. Now scattered radiation from the patient could be minimized through the use of an apron on the screen; similarly the leakage radiation through the slot can be minimized by mechanical means. Correction of each of these items may affect the other. The important thing is to think of all of them as making up a system and then apply a system's analysis to find the optimum solution.

Most of the above are problems of reeducation rather than education, yet if they are even worth mentioning, it indicates that the initial education has probably been inadequate.

RADIATION MONITORING

Mention has been made of the use of radiation monitoring to determine not only the general safety of operating procedures, but also whether the exposure of operating personnel is at the practical minimum.

It would seem reasonable that any radiological set-up involving, say, six persons (technicians plus radiologists) could well afford to have a dozen pocket ionization chambers and a charge-reader. With these the radiologist could easily make occasional routine checks of his radiation conditions; and even if these were generally satisfactory, it is almost certain that normal interest and curiosity about protection would lead to improvement in operating techniques. In addition, it is believed that the radiologist would have less trouble keeping his technicians happy and satisfied if they realized their safety was constantly being looked after.

Film badge dosimetry could also be applied, but in general the radiologist must be warned against doing his own film badge work if he is interested in quantitative results. For this he should take advantage of commercial film badge services. On the other hand, qualitative or exploratory measurements may be made with the time-honored combination of dental film and paper clip. With some experience the radiologist can develop a judgment that will enable him, from these observations, to decide when more or better radiation evaluation is indicated. He can then purchase some commercial film badge service as a quantitative check.

RADIATION LEGISLATION

Mention has been made of the growing tendency to obtain radiation protection by means of legislation. Whether or not this is desired by the radiologists the trend has already begun. For example, in one city a proposal is now under consideration that will make the chief radiologist in any hospital responsible for *all* radiation uses and protection therein. Under this regulation the surgeon using radium or the orthopedist using roentgen rays will be responsible to the radiologist for all matters of protection. Obviously the radiologist cannot be present during all operations; therefore, he must

educate these men in radiation protection practices to his own satisfaction before he can accept responsibility for them. To do this, he has to be well educated himself in those matters, and in addition he must to some extent become a good teacher.

Now this particular situation may or may not come about in the immediate future, but that is not important. What is important is the fact that some of our state authorities or others concerned with the general safety of individuals are beginning to consider such measures. In the immediate future, radiologists must either demonstrate convincingly that the thrusting of this type of responsibility upon them is not wise or necessary (if indeed it is not) or else educate themselves to accept it. This again suggests the need for more formal education in radiation protection than is generally available at present.

It is the opinion of most authorities on this subject that legislation alone cannot accomplish the desired result. Education is probably the most important area to be developed, for it can reasonably be said that we have at hand the essential technical facts and information necessary to attain an adequate degree of radiation protection for the whole population. The big problem is to bring this information to the attention of the populace in its proper perspective both with relation to the technological needs for radiation and the sociological obligations of the medical profession to mankind. While many people are coming to the opinion that under some circumstances legislative assistance may be of value, it is certain that we cannot legislate ourselves out of the problem.

A regulatory program instituted in a country made up of forty-eight separate states presents a very different problem from one instituted in a country operating with a single centralized government. In the extreme, we could have forty-eight different types of radiation regulation developing, on a national scale, into a chaotic and uneconomical situation. Radiologists should endeavor, therefore, to understand the essential features of the radiation regulation problem in the hope that the states may be aided in arriving at a common understanding of the problem. Efforts should be directed to the end that regulation, if any, may at least be developed along reasonably uniform lines.

One may say that the need for radiation control is obvious but this is an oversimplification; radiation can be dangerous, ergo we must protect ourselves from it. But when does one draw a line between the desired and practical end, and particularly, who decides where to draw such a line? Probably more people are killed or injured daily in the home in normal pursuits in one day than by radiation in one decade. In the home we can deal tangibly with the proper technique for mounting a ladder or avoiding electric shock or repairing a broken stair tread. But radiation is silent, unseen, unfelt; its presence can only be made known through elaborate instrumentation, and the damaging effects on the human system may not develop until many years after exposure. It is these intangibles that distinguish radiation hazard from the other more common hazards. They have developed in the lay mind a fear that in most cases is out of all proportion to its seriousness. Nonetheless, reasonable steps should be taken to minimize radiation dangers wherever they may exist. One encounters a very fine philosophical problem of where to draw the safety line in protecting individuals from radiation as compared with, say, automobiles. For one could make a reasonable guess that a dollar would save many more lives if spent to reduce highway as compared with radiation accidents. The big difficulty is that one cannot place a dollar value on a human life. For lack of a better base line, perhaps we should evaluate our radiation safety efforts to some extent on the cold economics of the over-all situation.

The question of who draws the radiation safety line has been raised; the answer is straightforward. Matters of radiation safety involve highly technical considera-

tions that can be adequately dealt with by only a relatively small number of highly specialized and experienced scientists and medical authorities. Once the basic principles have been established, the engineer can insure the practical accomplishment of protection. In any case the layman or legislator can do little if anything without the fundamental groundwork, and fortunately this is recognized by most people. Nevertheless, this situation introduces an important constraint, in any approach to the over-all problem, for the simple reason that there does not exist in the whole country enough radiation safety specialists to support, over the whole country, the degree of radiation regulation presently envisioned by one or two states.

In the development of radiation control legislation, careful thought must be given to the total problem. For example, it has been noted that some drafts of codes that have come to our attention have dealt only with radioactive isotopes, or roentgen rays, or roentgen rays and gamma rays. Instances have been noted wherein a requirement for one type of radiation, while reasonable in itself, would not be applicable to radiation from another source. Similarly, if too much detail is developed in a particular code, conflicts between medical, industrial or research applications can easily develop. Particular care must be exercised in any code that may apply equally to medical or research operations. The latter are generally of such a variable and unpredictable nature as to be difficult to control by detailed statutes. In an early draft of one code, it appeared impossible for some of the established research laboratories to continue operation if the code were rigorously enforced. Yet if radiation is to be regulated, research laboratories should not be completely excluded. They will, however, necessitate very special treatment, different from medical or industrial installations. Provision for this special treatment should be made in any code, without at the same time going into great detail.

Laws or legislation of any kind presumably offer certain advantages and solutions of specific problems. Only rarely, however, is there a law that does not also have some disadvantages or adversely affects certain classes of operations or individuals. The possible disadvantages of legislation should be given careful scrutiny and a careful balance drawn between the pros and cons. There may be sharp differences between states and this is one reason why national radiation legislation is generally considered inadvisable in this country, while perfectly acceptable in countries not similarly constituted.

Before any program of radiation legislation is begun, probably the most important single aspect to be considered is that of enforcement. Some proponents of legislation feel that to have laws on the statute books is a step forward, whether or not they are uniformly and fully enforced. The principal argument given is that by such means a state has a law as a threat, ready to be used if desired. This does not seem to be equitable or democratic and invites misuse. For example, there is the slightly different situation of outmoded laws still on the statute books, the neglect of which is taken as common practice. But not infrequently we hear of instances where such laws are invoked for harassment purposes or to accomplish some other end by indirect means. It is the opinion of most authorities, that unless it is intended and feasible to enforce a law rigorously, it is better not to have it in the first place. One must therefore evaluate in advance the many factors that will enter into an enforcement program—staffing and finances being two of the most critical items.

The problem of radiation legislation has been considered at some length because it has to do with education in all its ramifications. As a problem it will be with us more and more as time goes on, and its course will increasingly affect the most commonplace activities of the radiologist. It behooves him to learn a great deal about its general philosophy, its social implications, its medicolegal implications and so on.

It is certain that we are at the present time equipped technically to deal with the broad problem of radiation protection, but it is felt that socially and philosophically we are inadequately prepared to cope with the problems that are just around the corner.

Both the young men starting now in radiology and those who are already in the field must be educated in the basic principles and practices of radiation protection. They must take responsibility for the safety of persons in their clinics, offices, and laboratories and of themselves; they must in turn educate the new people entering the field of radiology and educate the general public; and of great importance in the immediate future, they must recognize these great responsibilities and the need for meeting them lest the initiative be taken by groups which lack an understanding of the problem.

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THE ROENTGENOGRAPHIC DIAGNOSIS OF GEOPHAGIA (DIRT EATING)*

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IT IS not generally known that geophagia, the eating of earth or clay (dirt eating), is widely practiced by adults of many races and in nearly every country on earth. Apparently it is not known at all that the eating of dirt may be suspected from findings on roentgenograms of the abdomen. We are unable to locate any report of the diagnosis of geophagia by means of roentgenography, nor have we found any physician who is familiar with the findings in this condition.

We believe the importance of recognizing geophagia from roentgenograms warrants the reporting of several cases. Geophagia may be suspected whenever there is an unexplained increase in radiopacity of the fecal content of the colon.

HISTORICAL

The literature on geophagia is surprisingly small. Termed "pica" by some authors, it has been reported in the bizarre appetites of pregnancy, debilitated states, hookworm disease, psychotic states and in children.[1–7,9–12] In a monograph published in 1930, Laufer[10] summarized the entire literature on geophagia, pointing out that humans have eaten dirt for many centuries. He comments that geophagia is no more unnatural than eating pepper, snails, or chewing tobacco, etc. Earlier writers had reported the practice in limited geographic areas, citing clinical experiences with one or at most a few cases.

Buschan[2] lists these reasons for the eating of dirt:

(1) Lack of food during food shortages.
(2) Enjoyment or "special treat."
(3) Craving during pregnancy.
(4) Religious practices and superstitions.

He describes the seasoning, toasting and baking of dirt in preparation for eating, and states that Negroes in Africa have been known to eat as much as 7 pounds of dirt per day. Gelfand[8] found no correlation between geophagia and ancylostomiasis in Negroes in Africa. The eating of laundry starch by Negro females in Southern United States has been described.[7,9] Dickins and Ford[3] found a high incidence of dirt eating among Negro school children in a county in Mississippi. Ferguson and Keaton[7] studied dirt and starch eating by pregnant women in Mississippi.

Many authors have commented on the lack of thorough investigations into the psychologic, dietary, sociological and other aspects of geophagia. There is obviously a need for a complete study of the incidence and causes of this habit.

A detailed review of theories concerning the various aspects of geophagia is not within the purpose of this paper. The reader is referred to the original communications in the bibliography.

REPORT OF CASES

CASE 1. L.P., Negro female, aged thirty. Roentgenogram of the chest was made because of suspected pneumonia. Radiopaque shadows were noted in the splenic and hepatic flexures of the colon (Fig. 1*A*). Roentgenogram of the abdomen revealed the entire colon to be filled with this radiopaque material (Fig. 1*B*). The patient denied ingestion of any medicine, nor had she undergone any roentgenologic studies. After persistent questioning, she finally admitted the daily consumption of large amounts of clay. After cleansing the colon, the opacity was no longer visible.

She was an apparently normal individual with no obvious mental aberrations, and was

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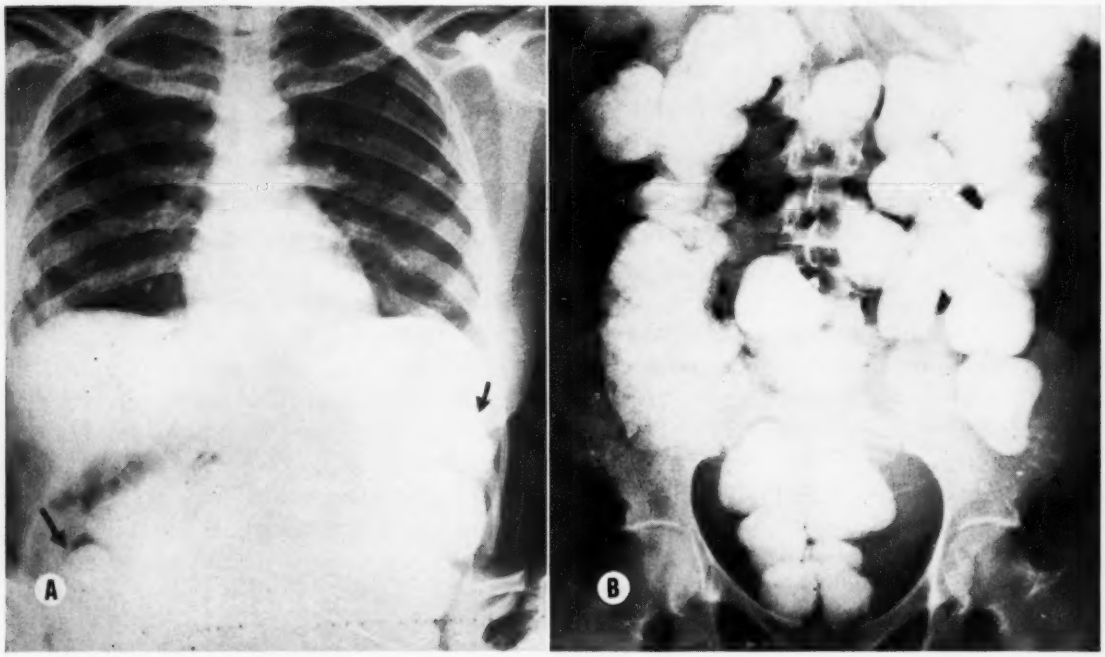

FIG. 1. Case I. (*A*) Roentgenogram of the chest showing opaque feces in the splenic and hepatic flexures of the colon. (*B*) Roentgenogram of the abdomen showing opaque feces filling the colon. Note uniform mixture of dirt and feces.

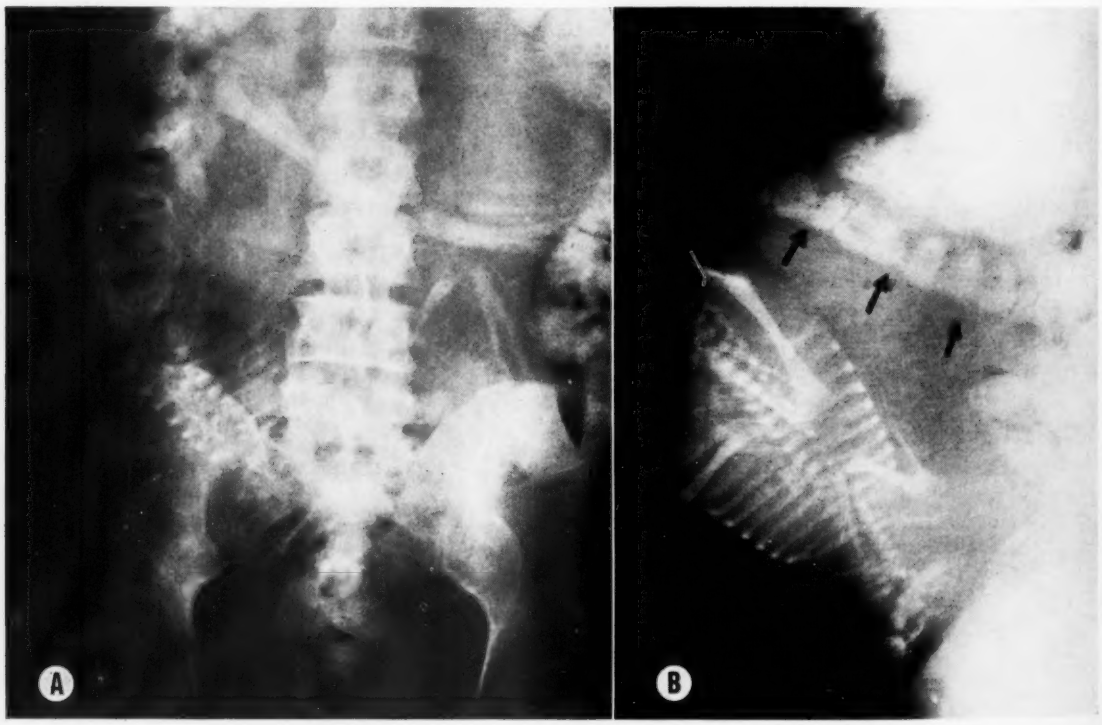

FIG. 2. Case II. (*A*) Anteroposterior roentgenogram of the abdomen showing opaque feces in the ascending and descending colon and in the rectum. Note coarse particles and uneven mixture of dirt and feces. (*B*) Lateral roentgenogram of the abdomen showing opaque feces in the transverse colon.

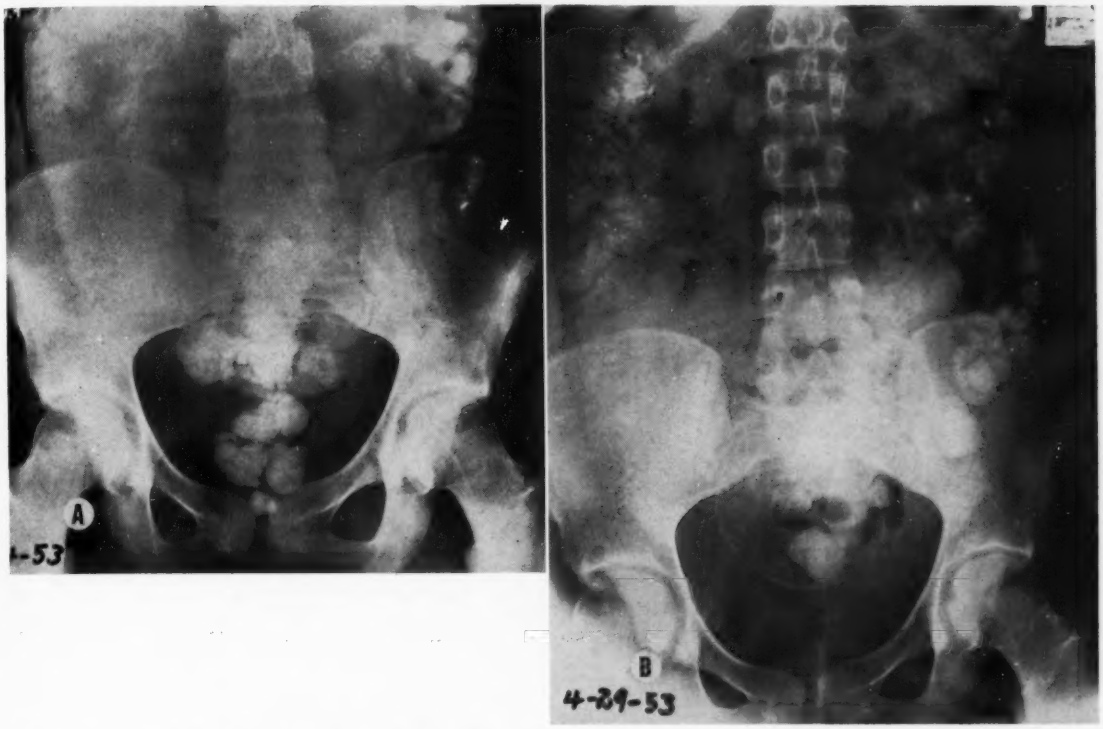

Fig. 3. Case IV. (*A*) Roentgenogram of the pelvis taken April 14, 1953, showing opaque feces in the rectum and faintly in the ascending and descending colon. (*B*) Roentgenogram of the abdomen taken April 29, 1953, showing opaque feces throughout the colon.

employed as a maid in the home of a professor of psychiatry. When we reviewed our cases of geophagia we learned that this patient had left Dallas and we were unable to obtain samples of the dirt eaten by her.

Case II. E.H., Negro female, aged forty, pregnant. Roentgenograms of the abdomen made for possible multiple pregnancy revealed the contents of the colon to be much more opaque than usual (Fig. 2*A* and 2*B*). She readily admitted eating dirt, stating that she had an intense craving for it. She began the practice two months before, after becoming pregnant, but had not eaten dirt during previous pregnancies. After delivery of the infant, she ceased to eat dirt.

Case III. R.W., Negro female, aged forty-five (sister of E.H., Case II). This patient was contacted through her sister. She had eaten dirt continuously since her first pregnancy eighteen years before. Her story is typical and will be described in some detail. She and another dirt eater alternately travel to a field just outside Dallas, Texas, for their supply of dirt. The top soil is removed to a depth of about 1 foot where a tasty bluish clay is reached. This dirt is prepared for eating by "washing" it in water. The excess water is drained away, forming a paste. This is spread about $\frac{1}{4}$ inch thick on a sheet of paper and is allowed to dry for several days in Texas sunlight, hardening to the consistency of fudge. It is then broken into 1 inch squares, wrapped in paper and stored out of reach of the children on top of a large chest. After meals, and especially after eating sweets, this patient craves dirt. She places a piece on her tongue and sucks on it until it has been swallowed.

A roentgenogram of this patient's abdomen failed to show any evidence of opaque medium. The failure to visualize was probably due to a low rate of ingestion and a low residue in the colon. We obtained a sample of this dirt. It was dark gray clay baked into a firm cake.

Case IV. R.E.J., Negro female, aged twenty-one, pregnant. This diagnosis was made from pelvimetric roentgenograms (Fig. 3*A* and 3*B*). This patient had one other child. She began to eat clay at the age of nine after observing her mother eat it. She craved more dirt while preg-

nant and was eating about two teacupfuls of dirt between meals when the roentgenograms were made. She preferred solid white dirt but all dirt tasted good to her. We obtained a sample of the dirt, a crumbly gray clay containing flecks of reddish material. The patient simply allowed the dirt to dry and ate it in the natural state with no preparation.

DISCUSSION

Since learning the roentgenographic findings in geophagia, we have interviewed many patients who eat dirt or who have eaten it at some time during their lives. We believe that the practice is quite common among Negro females of North and East Texas. Pregnant white women occasionally are known to eat dirt but do not have the habit as frequently as Negro women. Men of both races seem to eat dirt only rarely.

The increased radiopacity of the feces in the colon is found in some patients, while in others the feces are normally radiopaque. Absence of positive findings on the roentgenogram is probably due to a low rate of ingestion of dirt, to variation in radiopacity of the dirt consumed, or to a small fecal residue in the colon. For these reasons, we do not know how many dirt eaters pass through our service without being recognized.

The diagnosis of geophagia is suggested by the finding of unusually radiopaque colonic contents in a patient who has not had any roentgenographic contrast studies and who is not taking any medicines containing radiopaque ingredients. In some cases, the dirt is in large coarse particles, mixed with the feces; in others, the dirt is very finely divided and evenly mixed with the feces. In some geophagists, the feces is gathered into scybala, and in others it is spread along the lumen of the colon in a column. Since every case having positive findings showed a rather large collection of feces in the colon, this is probably an important requirement in recognizing geophagia from roentgenograms.

We wish to emphasize the importance of a proper approach in interviewing patients suspected of geophagia. The reluctance of the Negro to discuss this habit with a white man has been pointed out.[8] We have also observed this reluctance. The patient will often deny the practice unless he is assured by the interviewer that no harm or publicity will result from his admitting the eating of dirt. The patient will describe intimate details of the search for particularly tasty earth and its careful and almost ritualistic preparation for consumption. Others have commented on the intensity of the craving for dirt and starch by these patients.[2,7,9]

The recognition of geophagia may provide a clue to the patient's difficulties for which the roentgenographic study of the abdomen was made. If the amount of dirt consumed per day is excessive, essential food intake may be inadequate, resulting in deficiency states. Cachexia africana is a syndrome exhibited by Negroes in Africa who eat so much dirt they become severely emaciated and some eventually die. Dropsy has been reported in native women of India who eat 1 to 1½ pounds of dirt per day for a year or more.[8] Ova of intestinal parasites can be ingested with raw dirt. Borderline psychotic states are sometimes associated with abnormal appetites. It has been suggested that a lack of certain essential dietary factors may cause a craving for dirt. We cannot find any evidence that the eating of reasonably small amounts of dirt is in any way injurious to humans. However, the clinician may be furnished valuable information by the radiologist who suggests geophagia from the roentgenographic study.

SUMMARY

1. Four cases of geophagia are reported.

2. The roentgenographic findings in geophagia are presented.

3. The importance of recognizing this condition from roentgenograms of the abdomen is emphasized.

4. A proper approach is necessary in interviewing patients suspected of geophagia.

5. The practice is apparently widespread among the Negro population of North and

East Texas as well as in many parts of the world.

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CEREBRAL COMPLICATIONS FOLLOWING CARDIOANGIOGRAPHY*†

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THIS report concerns severe neurological complications following cardioangiography using retrograde brachial artery injections with 70 per cent diodrast. Two cases are discussed.

REPORT OF CASES

CASE I. (U.H. 860555.) A woman, aged fifty-six, gave the history that she was in good health until three years prior to hospital admission, at which time she noted the onset of pain located in the left posterior chest region. These pains were aggravated by coughing and forced respiration. The pain lasted for various periods of time, sometimes as long as several weeks. Gradually they subsided and she was free of pain until approximately two and one-half weeks prior to admission. Then the pains recurred and were identical to those previously present.

At the time of admission to the hospital on July 20, 1953, her blood pressure was 180/120 mm. Hg. General physical and neurological examinations were essentially normal except for a grade 2 systolic murmur heard best over the left second and third interspaces along the sternal border. Laboratory studies revealed essentially normal hemogram and urinalysis. Her erythrocyte sedimentation rate was 65 mm. per hour. Blood Wassermann reaction was reported as 4 plus. Electrocardiogram was normal. Chest roentgenogram was suggestive of an aneurysmal dilatation involving the arch of the aorta. Further investigation included a retrograde aortogram done on August 5, 1953. The left brachial artery was visualized and cannulated. It was injected with 45 cc. of 70 per cent diodrast. During the injection, the patient became diffusely hyperemic, developed spastic contractions of the upper extremities and then became aphasic. The blood pressure at that time was 170/115 mm. Hg. Weakness of the left side of her face was noted. She became comatose and had episodes of generalized convulsions. She died eight hours after the procedure.

Autopsy examination of the central nervous system revealed no abnormality on gross inspection. Microscopic sections of the cortex, basal nuclei, and medulla showed only mild arteriosclerotic changes with a number of macrophages and mononuclear leukocytes in a few of the perivascular areas. There was no evidence of luetic involvement.

CASE II. (U.H. 860942.) A woman, aged sixty-five, was admitted to the Dermatology Service on August 17, 1953, because of "leg trouble" of one year's duration. While in the hospital a routine chest roentgenogram was obtained and this revealed a mass in the left superior anterior mediastinum. She was transferred to the medical service for further investigation. Additional history revealed that on several occasions she had experienced mild left chest pain which was relieved by moving her shoulders around, or by deep breathing. It was also known that she had a mild hypertension for approximately one year's duration.

On examination, her blood pressure was 150/80 mm. Hg. Retinoscopy revealed minimal arteriolar narrowing. Her heart was slightly enlarged to the left. There was a grade 2 systolic murmur heard over the entire precordium. The liver margin was palpable 3 cm. below the right costal margin.

Laboratory examination revealed the hemogram, urinalysis, and erythrocyte sedimentation rate to be normal. Blood serology was negative. Electrocardiogram showed left axis deviation and nonspecific T-wave changes.

The diagnoses of stasis dermatitis of the legs and of a left superior anterior mediastinal mass, possibly an aneurysm in the great vessel region, were made.

On September 11, 1953, a retrograde aortogram was performed under nitrous oxide and oxygen anesthesia. The left brachial artery was isolated and cannulated. Thirty-one cubic centimeters of 70 per cent diodrast was injected. The patient seemed to tolerate the procedure well, but while being transported back

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to her bed, Cheyne-Stokes type respiration was observed. She began to respond very poorly. Her blood pressure was then 104/60 mm. Hg. Examination revealed no localizing neurological signs. She remained in the same general condition for the next twenty-four hours. Vasopressor drugs were used intermittently to combat hypotension. On the next day, bilateral Babinski signs were noted. During the succeeding few hours, she developed flaccid paresis of both arms, the right being more involved than the left. She gradually improved over a period of several weeks. On October 11, 1953, a month after the aortogram, she had recovered sufficiently to be able to sit up in a chair. Motor strength in her arms was fair. Her mental condition was sufficiently improved so that she could carry on an intelligent conversation.

DISCUSSION

Several factors are involved in the production of these complications. It is difficult to be certain which ones are most involved in a specific case but certainly any of them may play a part. First, it is known that contrast media such as diodrast, urokon, and neo-iopax may disrupt the blood-brain barrier.[2,5] The degree and duration of this disruption is a function of the amount and concentration of the media as well as the pressure under which the injection is made. Damage to brain tissue by the contrast media may range from transient physiological disturbance without demonstrable microscopic abnormality to severe necrosis with petechial hemorrhages and edema.[1]

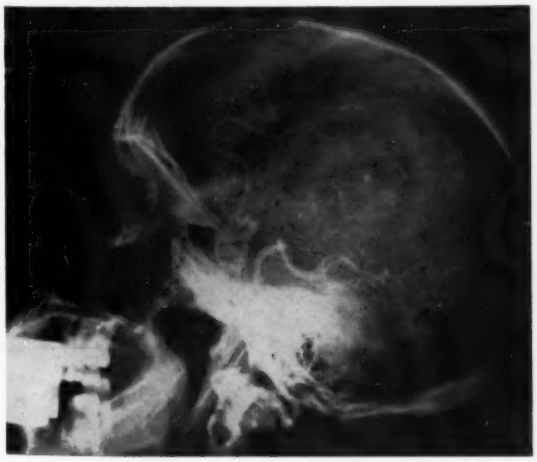

Fig. 1. Cerebral angiogram. Right brachial artery retrograce technique with 35 per cent diodrast. Note filling of internal carotid, vertebral and their cerebral branches. Posterior communicating artery is shown, but not well visualized.

Fig. 2. Retrograde aortogram; note filling of vertebral artery.

Second, it has been established that contrast media such as diodrast are transient vasodilators. In concentrated form it is also a myocardial depressant.[3] Both these factors tend to produce hypotension which in turn may precipitate intravascular thrombosis.

Third, by the technique used in retrograde aortography there always is a strong possibility that an unpredictable proportion of the contrast medium will ascend the carotid and vertebral vessels into the cerebral vascular system. This is less likely with injections via the left subclavian artery than the right because of the anatomical variation of origin of the carotid arteries. On the left the contrast medium, injected under pressure greater than the systolic blood pressure, is diluted by the main channel blood of the aorta. Proportionally less medium is apt to go up the carotid vessel. On the right, from a practical stand-

point, both the carotid and vertebral vessels arise from the subclavian. A retrograde injection on this side will often fill both vertebral and carotid arteries. To illustrate, in this clinic open retrograde brachial artery injections of 35 per cent diodrast have been used to fill both carotid and vertebral arteries for diagnostic purposes[4] (Fig. 1). With this same technique, used on the left, it is very infrequent that adequate filling of the cerebral system is obtained. Still the above two cited complications ensued from injection on the left side. Apparently sufficient contrast medium to produce these complications did ascend the carotid and/or the vertebral vessels (Fig. 2). The fact that 70 per cent diodrast was used made necessary less quantity of the solution to produce damage.

In these 2 reported cases, it is reasonably certain that the contrast media caused at least temporary damage to the central nervous system, thereby producing profound neurological symptoms in one and death in the other. The loss of consciousness observed may well be due to temporary physiological disruption of the vital centers in the brain stem. Furthermore, the general vasodilating and cardiac depressant effect of the contrast media probably contributed to the unfortunate outcome. There seems to be no question that under certain circumstances 70 per cent diodrast used in cardioangiography can produce serious cerebral damage.

SUMMARY

Report is made of two cases of severe neurologic disability following angiocardiography with 70 per cent diodrast. A discussion of possible causative factors is given. The need for further investigation of such complications is stressed.

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THE ROENTGEN APPEARANCE OF LOCALIZED HYPERPLASIA OF THE LYMPHOID FOLLICLES OF THE DUODENUM*

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CORRELATION of the roentgen appearance with the gross and histological findings is one of the requisites of successful diagnosis. The following case should aid such correlation by illustrating one of the several conditions which may give the configuration of numerous small, rounded radiolucencies in the barium-filled duodenal bulb.

Horncastle[4] gives the following classifications of the possible causes for such filling defects:

1. Intrabulbar Causes
   (a) Gas or food in the cap.
   (b) Swallowed foreign bodies, undissolved medicinal tablets.
   (c) Gallstones; there are two routes by which gallstones can enter the duodenal cap:
      i. Ascent from the descending limb of the duodenum.
      ii. Ulceration directly into the cap from the biliary tract.
   (d) Prepyloric, pedunculated polypus, part of which has passed through the pylorus.
   (e) Ascaris lumbricoides.
2. Intrinsic Causes
   (a) Duodenal ulcer, seen en face.
   (b) Scarring due to healed ulcer.
   (c) Axial view of the open pylorus.
   (d) Simple hypertrophy of the mucosa due to long-standing duodenitis.
   (e) True polyposis.
   (f) Benign tumours—fibroma, lipoma, fibromyoma.
   (g) Polypoid haemangioma (Carman, quoted in Lehrbuch).
3. Extrabulbar Causes
   (a) Adhesions involving the duodenal cap.
      i. Post-operative.
      ii. With periduodenitis, perigastritis, pericholecystitis, etc.
   (b) Pressure on the anterior or posterior walls of the cap, causing indentation.
      i. Enlargements of the gall-bladder, cystic duct and common bile duct.
      ii. Gallstones within the biliary tract tract (Kohler).
      iii. Malignant tumours—stomach (prepyloric duodenum, pancreas liver).

To this should be added, under the heading "Intrinsic Causes," the unique case of hypertrophied Brunner's glands reported by Erb and Johnson.[3] Aberrant pancreatic tissue will also give similar radiolucent bulbar defects.[5]

The case herein reported adds yet another intrinsic cause to the list.

CASE REPORT

A.M., aged sixty-three, gave a long gastrointestinal history of anorexia, belching, nausea and intolerance to starchy foods. Recently anginoid symptoms had appeared.

Physical examination failed to contribute any significant abdominal findings to explain the gastrointestinal component in the history. Roentgen examination by gastrointestinal series showed the small, rounded radiolucent defects seen in the spot roentgenogram (Fig. 1) and in the polygraph view (Fig. 2). These radiolucent defects were constant in all four spot roentgenograms and polygraph views.

Autopsy revealed "lymphoid hyperplasia of the duodenum with polypoid formation." In addition there were: arteriosclerosis of the coronary arteries and of the aorta; infarcts of the myocardium; hypertrophy of the heart; infarcts of the kidneys; passive congestion of the liver, spleen and lungs; emphysema of the

* Reviewed in the Veterans Administration and published with the approval of the Chief Medical Director. The statements and conclusions published by the author are the result of his own study and do not necessarily reflect the opinion or policy of the Veterans Administration.

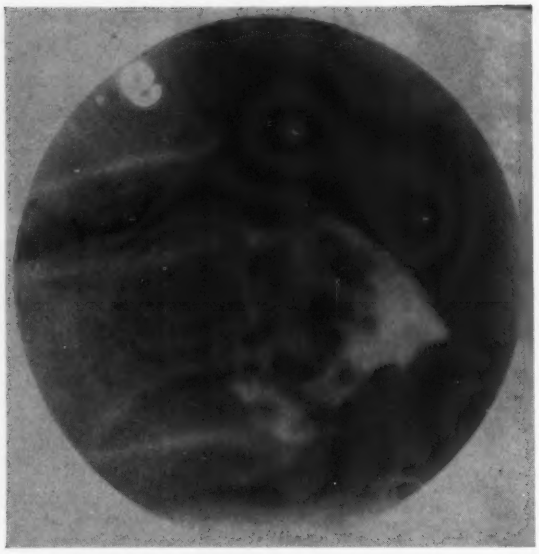

FIG. 1. Spot roentgenogram of duodenal bulb showing radiolucent defects.

lungs; and encephalomalacia of the left pons.

The pseudolypoid appearance of the mucosa of the bulb in the gross specimen is well seen in Figure 3 and the photomicrographs (Fig. 4 and 5) show the histopathological appearance; the identity of the small pseudopolypoid protuberances are here conclusively proved to be prominent lymphoid follicles.

DISCUSSION

On the basis of the roentgen appearance air bubbles in the chyme passing through the bulb would have been the most likely interpretation for the radiolucent defects shown in Figure 3. Second to this, food particles, droplets of mucus, a pseudopolypoid configuration of the mucosal folds or else a true polyposis would have to be considered. Against air bubbles was the fact that the appearance was constant in all four spot roentgenograms and in the polygraphs. Furthermore, the defects as seen here are not as perfectly spherical as air bubbles are apt to be.

The physiological and pathological significance of these lymphoid follicles is uncertain. They may possibly be the result of some irritation or inflammation. They were not present in stomach or jejunal mucosa. Review of the literature as far back as 1928 does not reveal any identical case. Haber[1] shows a photomicrograph of a section of stomach wall demonstrating a somewhat lymphoid hyperplasia, entitled "Chronic Follicular Gastritis." Buckstein[2] presents a roentgenogram with a very similar configuration of the duodenal bulb; he interprets this appearance as indicating "unusually prominent mucosal folds of the duodenal bulb with polypoid appearance."

FIG. 2. Polygraph of duodenal bulb showing marginal radiolucent defects.

SUMMARY

A case is presented of localized lymphoid hyperplasia of the mucosa of the duodenal

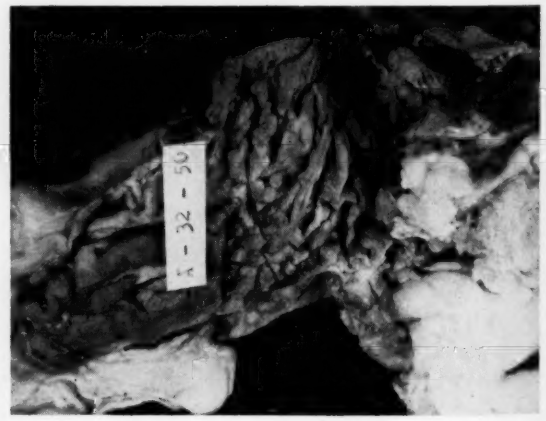

FIG. 3. Gross specimen of duodenal bulb with small, rounded prominences due to prominent lymphoid follicles.

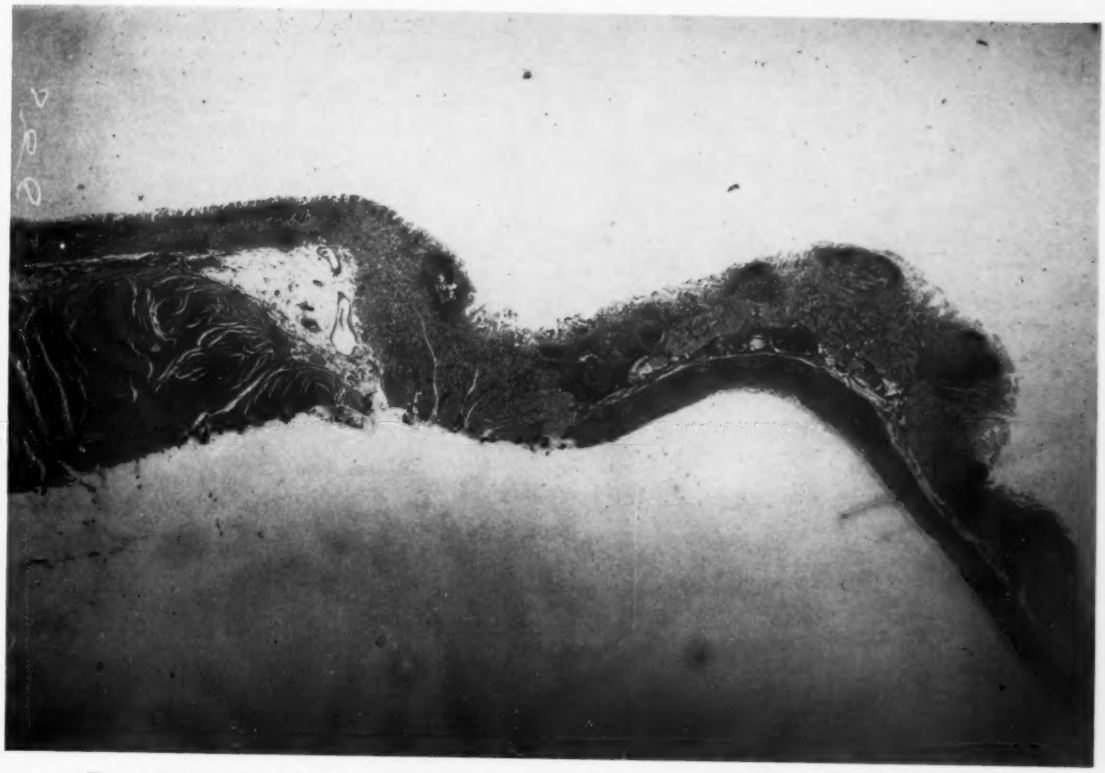

Fig. 4. Photomicrograph of section of duodenal wall showing numerous lymphoid follicles.

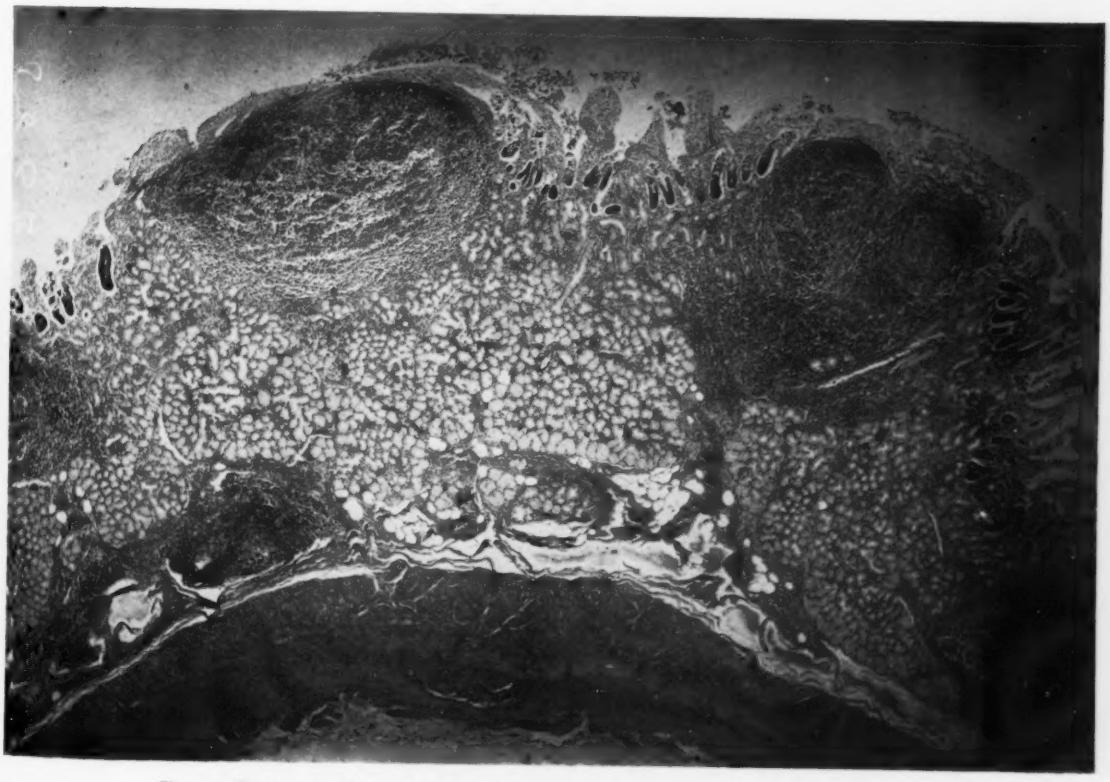

Fig. 5. Enlarged photomicrograph of several hyperplastic lymphoid follicles.

bulb with small, rounded prominences, giving a characteristic roentgen appearance.

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ROENTGEN VISUALIZATION OF ROKITANSKY-ASCHOFF SINUSES*

A CASE REPORT

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A REVIEW of the literature reveals only 2 previously reported cases of Rokitansky-Aschoff sinuses visualized during cholecystography. Although these sinuses are not too infrequently seen in pathological specimens, their apparently comparatively rare roentgen visualization would seem to justify this report.

CASE REPORT

A.L., a Negro male, aged forty-one, entered the hospital complaining of headaches, nervousness and abdominal distress. The patient had a history of hypertension dating back to 1943. In addition, he also gave a history of progressive cardiorespiratory difficulty for the past two to three years.

The abdominal distress mentioned above consisted of postcibal nausea without vomiting. It was aggravated by fats and had been present for only one month prior to admission.

Physical examination revealed a well developed and well nourished male in no acute distress. Temperature, 98.6° F.; pulse, 84; blood pressure 170/100.

The examination, with the exception of the blood pressure and grade 1 arteriosclerotic changes in the fundi, was essentially negative.

Laboratory Findings. The hemogram and urinalysis were normal while the serological test for syphilis was negative. The Fishberg concentration test revealed the highest specific gravity of 1.015. The blood urea nitrogen was 12.9 mg. per cent and the blood glucose level was 117.5 mg. per cent. Gastric analysis revealed the presence of free hydrochloric acid with the highest total acidity being 80 degrees, 55 of which were in the free state. An electrocardiogram exhibited T wave changes which were interpreted as being consistent with myocardial damage.

Roentgen Findings. An initial combination upper gastrointestinal series and cholecystogram failed to reveal any organic lesion of the upper gastrointestinal tract. Five questionable irregular densities seen within the region of the gallbladder shadow were interpreted as representing possible stone formation.

A repeat cholecystogram showed no evidence of stone formation or other abnormality on a survey roentgenogram. Following the oral ingestion of priodax, the gallbladder was visualized without evidence of lithiasis. A concentric rim of contrast material was seen around the gallbladder shadow distal to a constriction near its neck. The rim of contrast medium, which was better seen following a fatty meal, was interpreted as being visualization of Rokitansky-Aschoff sinuses. It was assumed that the constriction was a congenital phenomenon, but the possibility of its being a stricture was entertained. Because of the visualization of the sinuses, a presumptive diagnosis of gallbladder pathology (cholecystitis) was made.

Surgery. Following a surgical consultation and the completion of adequate blood studies (bleeding time, coagulation time, prothrombin time, blood urea nitrogen and icteric index) plus liver function tests (bromsulphalein and cephalin flocculation), all of which were within normal limits, the patient was operated upon.

The gallbladder was tense and red with a markedly thickened wall distal to a constriction present between the proximal one-quarter and distal three-quarters. The proximal fourth was normal to appearance and palpation. No adhesions were present. The cystic and common ducts were not dilated and they contained no palpable stones. When the gallbladder was sectioned, large Rokitansky-Aschoff sinuses containing pigment were visualized. The constriction was well visualized, but it could not be determined whether it was congenital or acquired.

* Reviewed in the Veterans Administration and published with the approval of the Chief Medical Director. The statements and conclusions published by the authors are their own and do not reflect the opinion or policy of the Veterans Administration.

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FIG. 1. Roentgenogram made following a fatty meal clearly shows the concentric layer of contrast medium around the gallbladder shadow. Note also the constriction in the gallbladder and the phrygian cap.

FIG. 2. Gross surgical specimen showing the pigment-filled sinuses penetrating the wall of the gallbladder (arrows). Clamps indicate the area of constriction.

A cholangiogram failed to exhibit any stones in the ducts.

Microscopic Pathology. The histopathological description was as follows: "There are several

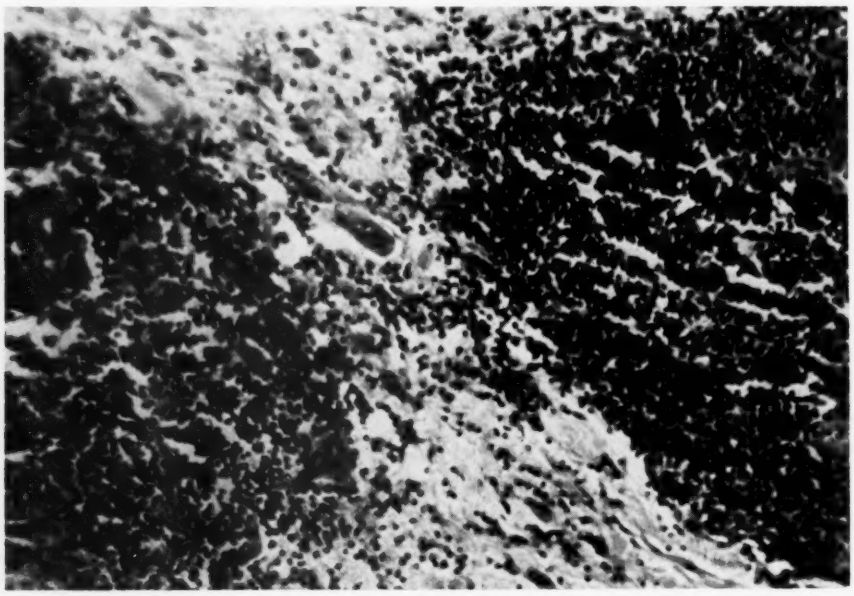

FIG. 3. Photomicrograph of a cross-section through the gallbladder wall exhibiting fibrosis and leukocytic infiltration—changes indicative of chronic cholecystitis.

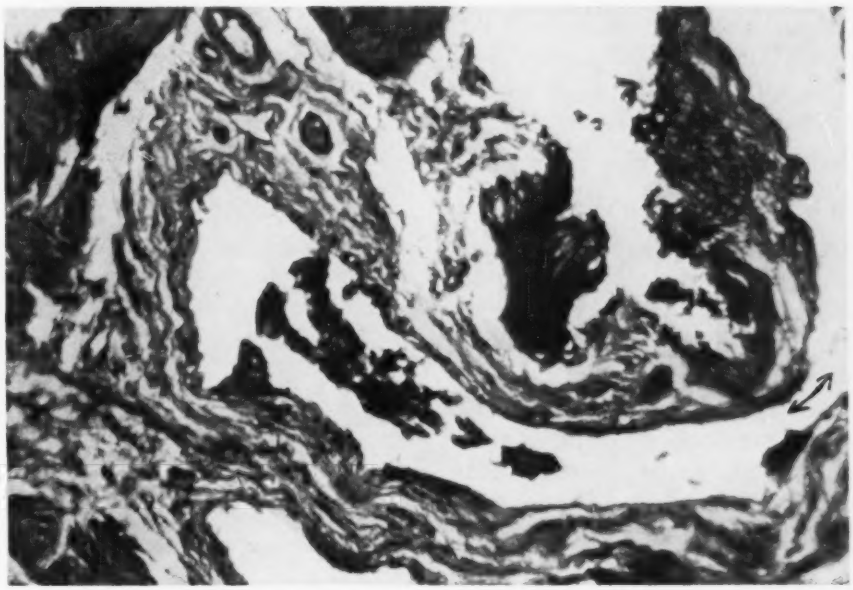

Fig. 4. Photomicrograph of a cross-section through the gallbladder wall exhibiting a pigment-containing sinus which communicates with the lumen of the viscus.

sections of gallbladder, the walls of which are greatly thickened by connective tissue in which both fibroglia and collagen fibrils are present. In the stroma, several pockets lined with columnar epithelial cells are seen. Many of these pockets communicate with each other. Some are filled with inspissated bile while others are empty. A heavy infiltration of mononuclear cells is present; both loosely scattered and as follicular groupings. At one edge, remnants of atrophic mucosal folds are seen. Diagnoses: Chronic cholecystitis; Rokitansky-Aschoff sinuses."

Result. The patient was discharged improved on the seventeenth postoperative day after an uneventful course.

COMMENT

As has been pointed out in previous communications, Rokitansky-Aschoff sinuses are outpouchings or herniations of the gallbladder mucosa through the muscularis. Presumably, these herniations occur only in the walls of diseased organs, since it is assumed that the muscularis of a healthy wall is dense enough to prevent them. Pathologically, the contractile elements are weakened and the intermuscular septa are widened, following which chronic overdistention of the viscus probably produces the herniations.[2]

Rokitansky-Aschoff sinuses are frequently seen in pathological specimens. Gallbladders containing these sinuses usually exhibit thickened walls secondary to inflammatory cell infiltration, increased connective tissue and edema. In other words, they exhibit the signs of chronic cholecystitis. Whereas the sinuses are not too infrequently seen pathologically, roentgen visualization does not appear common. One reason for this, of course, is the poor visualization of the gallbladder which is common in chronic cholecystitis.

The roentgen appearance of these sinuses, which appears typically to be characterized by a rim of contrast medium passing concentrically around the gallbladder shadow, was first reported by March[3] in 1948. Following that, Bean and Culver[1] reported the second case in 1950. It was felt that a comparison with the previous findings might be of some value and, as a result, the following comparative points are enumerated:

(1) Bean and Culver visualized the sinuses only after a fatty meal; March

visualized them prior to the ingestion of the fatty meal, but visualization was much improved following the meal; in this case also, the sinuses were visualized prior to the meal with improved visualization following it.

(2) In all 3 cases, the two previously reported and the present one, a definite constriction was found in the upper portion of the gallbladder. The sinuses were visualized distal to the constriction (in the fundus only). The origin of the constriction has not been settled. In March's case, it was felt that the constriction was congenital—so, too, in this present case. In the case of Bean and Culver, however, it was felt rather that it was an acquired phenomenon.

(3) Bean and Culver found stones in their case; in March's case and the present one, no substantial evidence of lithiasis was found.

(4) Finally, in all 3 cases, there was histopathological evidence of chronic cholecystitis. This fact, and the uniform appearance of the sinuses on roentgen examination, are probably the most significant findings elicited from a comparison of these 3 cases.

SUMMARY

A case of roentgen visualization of Rokitansky-Aschoff sinuses in a diseased gallbladder is reported. The findings are correlated with previously reported data.

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The authors wish to express their appreciation to the Departments of Surgery, Pathology and Medical Photography for their gracious cooperation.

ADDENDUM

Since this article was written, one more case has been reported, by Sukman and Daron (Sukman, R., and Daron, P. B. Roentgen visualization of Rokitansky-Aschoff sinuses as additional sign of chronic gallbladder disease; case report. *Radiology*, 1953, *60*, 714–717).

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ANENCEPHALY IN TWINS*

DIAGNOSED ANTEPARTUM BY ROENTGEN EXAMINATION

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ANENCEPHALY is not an unusual condition. Three hundred and fifteen cases of anencephaly accumulated from reports of various authors were found among 434,677 births.[6,10] The reported incidence varies from 0.3 to 3.08 and averages 0.72 per one thousand births. It occurs extremely infrequently in twins. Only 9 such cases could be traced (see Table 1). In

TABLE I

INCIDENCE OF ANENCEPHALY AMONG TWINS

Authors	No. of Cases	Sex	One Anencephalic	Both Anencephalic
Thompson[28]	1	M	X	
Naud and Gallocher[20]	1	F	X	
Andersen[1]	1		X	
Böök and Rayner[6]	3		X	
Potter[23]	1		X	
Josephson and Waller[14]	1	F		X
Dunn and Salter[11]	1			X
	9		7	2

7 of these only 1 of the twins was anencephalic while in 2 instances anencephaly was present in both twins. One of these cases[11] was cited as the result of a personal communication and was not reported in detail. The diagnosis has rarely been made before birth. Roentgen examination is the only means of establishing an antepartum diagnosis. The early recognition of this anomaly is of help to the obstetrician in the proper management of the patient. We are reporting what is to the best of our knowledge the second case of anencephaly in both twins and the first case in which an antepartum diagnosis was made.

THEORIES ON ETIOLOGY

Hereditary Aspects. Murphy[16] studied several series of mothers who gave birth to infants with malformations and found additional malformations in 12.4 per cent of these families. The same anomaly recurred in the offsprings of 3.4 per cent of the mothers.[17] He concluded that the frequent duplication of defects favors a hereditary basis of the defect.[18] In families with one congenital anomaly, the chance of occurrence of further defects is about twenty-four times greater than in previously normal families.[16] Anencephaly has been known to occur up to six times in a single family.[11] Anomalies such as spina bifida, hydrocephalus and Klippel-Feil's syndrome have been associated with anencephaly in a number of cases.[22]

The presence of anencephaly in both identical twins led Josephson and Waller[14] to the conclusion that the condition is due to inherited trends rather than to an antenatal accident. In spite of the gross cranial defect common to both twins resulting probably from the same basic cause, the extreme differences in bodily development led these authors to believe that environmental conditions, such as intrauterine relationship, may be important factors which influence the development of the fetus.

Sex Incidence. An average ratio of 3 females to 1 male suggests a hereditary factor, probably due to a derangement of the sex chromosome according to Penrose.[22]

Environmental Aspects. Advanced maternal age has been suggested by some[19,22] as a factor in the incidence of nervous system anomalies but has been denied by others.[6]

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Maternal diseases such as previous infections, menstrual disturbances, disease of the endometrium, anemia, nutritional deficiencies and mechanical pressure are mentioned by various authors as possible environmental factors. Rubella during the period of pregnancy has been reported as a definite cause of some congenital anomalies.[27] Even shock, worry, and deprivation have beeen mentioned as possible causes.[4,9]

Experimental Aspects. Anencephaly, spina bifida and other allied anomalies of the nervous system have been produced in animals by various physical and chemical means. Hertwig[13] and Morgan[15] used concentrated salt solution on frog's eggs to produce results similar to anencephaly and spina bifida in man. Baldwin[3] obtained similar results with ultraviolet rays. Snell and Picken[25] found a strain of mice derived from a roentgen irradiated male in which a high incidence of failure of closure of the anterior end of the neural groove occurred. Stockard[26] revealed that alteration of temperature or oxygen supply was a frequent cause of abnormal development. Murphy mentioned that malformations such as microcephaly may be produced by irradiation.

Pathogenesis. Tribedi and Roy[29] stated that "the arrest in development of the brain and the spinal cord is due to failure of closure of the neural tube posteriorly about the fourth week. Thus the neural plate, by exposure to the amniotic fluid at the cephalic extremity becomes atrophic. The presence of cicatricial tissue in this part indicates that circulatory failure probably is the cause of anencephaly."

Anomalies of endocrine glands are an interesting feature. Ettinger and Miller[12] have summarized the findings of various authors. The absence of the pineal body and sometimes of the nervous element of the pituitary gland may be related to aplasia or hypoplasia of the adrenals and may also be associated with skeletal and visceral anomalies.

Adrenal aplasia or hypoplasia, particularly of the cortical portion, with excessive gyrification and diminished total substance to as much as one-tenth of its normal size is characteristic of anencephaly. Abundant lipoids are almost always present.

Hyperplasia of the thymus and of the thyroid are found occasionally. Experimental work has demonstrated that adrenalectomy in sexually immature rabbits may cause hypertrophy of the thymus gland.[12]

The presence of choroid plexus within the mass of underdeveloped brain tissue was thought to contribute to the hydramnios.[2]

DIAGNOSIS

Case[8] reported the first antepartum diagnosis of anencephaly by means of roentgen examination. To date about 50 cases[1,2,5,7,21,24,30] are recorded in the available literature where particular mention is made of the role of roentgenological diagnosis. The number of cases is very small compared to the total number of reported cases of anencephaly.

The clinical signs and symptoms associated with the condition are hydramnios, especially during the seventh or eighth month of pregnancy, uncertain or feeble fetal heart sounds and abdominal pain due to convulsive movement of the fetus. Where any suspicion of abnormal pregnancy exists, a roentgenogram should be made to rule out the possibility of anencephaly. This is particularly true when the patient has a family history of malformations.

The ease with which this diagnosis can be made from the roentgenogram has to be stressed. Occasionally the absence of the calvarium may be mimicked by rapid movement of the fetus. Blumberg and Teplick[5] have emphasized that even when the skull shadow has been obliterated by movement, the prominence of two small round bony knobs, the sphenoids, is characteristic of anencephaly. One should also look for defects of the spine because of the common association of this condition with anencephaly. The increase in the size of the

uterus may be far out of proportion to fetal growth. This is the result of rapidly accumulating fluid which commonly occurs in the last trimester. Defects of the base of the skull, pituitary fossa, and orbits may be observed at times as additional diagnostic evidence of anencephaly.

CASE REPORT*

Mrs. M.M., a Mexican housewife, aged thirty-three, gravida VI, was first seen in the Obstetrical Clinic on October 18, 1950, in her ninth month of gestation. Four children are living and well, one died in infancy of "stomach trouble."

Past history revealed that the patient had measles, mumps, and chickenpox during childhood. Her present pregnancy had been uneventful.

Physical examination disclosed a uterus 41 cm. above the symphysis pubis. Fetal size and position could not be determined. Laboratory examinations were essentially normal. Prenatal roentgen examination on October 20, 1950, (Fig. 1) disclosed the presence of anencephalic twins; one (A) with the head presenting and the other (B) in breach presentation.

Normal labor occurred about three weeks later than expected and four weeks following roentgen examination. Both female anencephalic twins were stillborn. The patient had an uneventful postpartum course.

Examination of the single placenta revealed two umbilical cords with normal twin insertion 2 cm. apart and one small marginal area of fibrosis due to infarction.

Twin A (see Fig. 2). The body is 45.7 cm. long and weighs 2,150 grams. The calvarium is absent and the brain tissue is replaced by a bluish-red cystic mass 9 by 5 by 2 cm. The neck is short. The subcutaneous fat is 1.5 cm. thick. Bilateral and symmetrical exophthalmos is present. Respiratory System: Patchy areas of atelectasis and emphysema are seen in the lungs (result of artificial respiration performed). Cardiovascular System: The foramen ovale is anatomically patent. Endocrine System: The combined weight of both adrenals is 1.6 gm. (normal 4.7 to 5 gm.). Microscopic examination reveals a large amount of lipids in the cortex. Only the anterior lobe of the hypophysis is recognizable. Most of the cells are chromophobes but a moderate scattering of eosinophils is present. The thyroid gland weighs 1.1 gm. Central Nervous System: The small mass of basal brain tissue reveals an ependymal lining and a choroid plexus. The meninges appear to be thickened and fibrotic both grossly and microscopically. No pineal body can be detected.

Fig. 1. Roentgenogram of maternal abdomen taken four weeks antepartum.

Twin B (see Fig. 2). The body is 43.2 cm. long and weighs 2,320 grams. The calvarium is absent and the brain tissue is replaced by a bluish cystic mass 1.5 by 1.5 by 1.5 cm. in the anterior fossa of the skull. The neck is short, the eyes protrude. The subcutaneous fat is excessive. Respiratory System: Examination of the lungs reveals fetal atelectasis. The lung weighs about one-half of the normal; the right lung weighs 8 gm., the left lung weighs 7 gm.; the histological structure is not remarkable except for scattered areas of recent hemorrhage. Cardiovascular System: A bicuspid aortic valve and a patent foramen ovale are present. Endocrine System: The adrenals weigh 0.7 gm. Hemorrhages are found in the boundary zone; vacuoles are present in the cells of the zona fasciculata. Extracapsular adrenal nodules are observed. Fat stains reveal large amounts of lipids. The hypophysis contains numerous

* Courtesy of Dr. E. G. Holmstrom.

FIG. 2. Stillborn anencephalic twins. (A) Twin A; (B) Twin B.

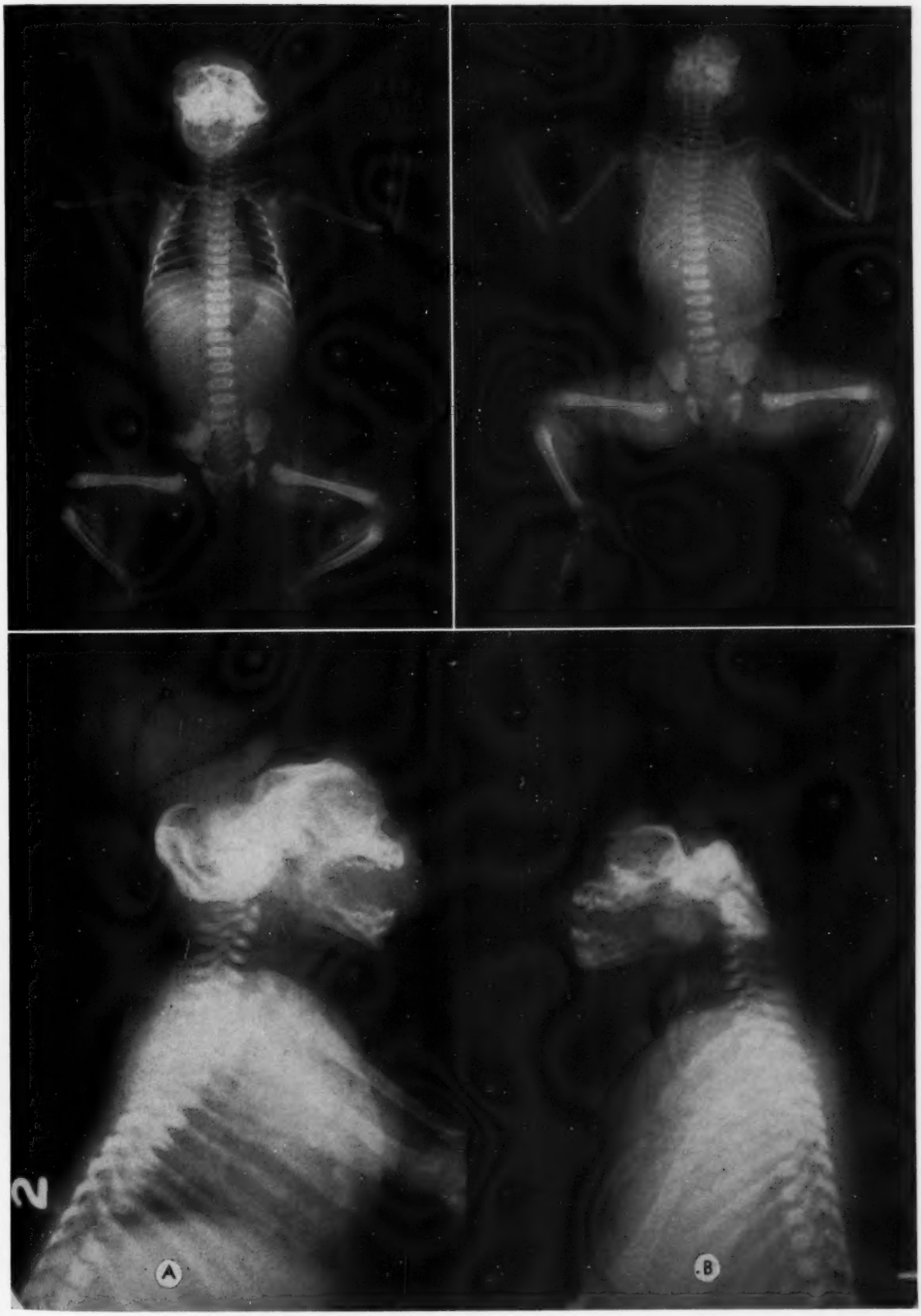

Fig. 3. Roentgen examination of anencephalic twins. (A) Twin A; (B) Twin B.

large chromophobe cells but only a few eosinophils. Only a minute portion of tissue resembles a pars nervosa. The thyroid gland weighs 1.5 gm. and the thymus 14.5 gm. Genitourinary System: A double renal pelvis and a partial double ureter are seen on the right side. The genitalia are normal. Central Nervous System: Aside from the features described, the spinal cord reveals no remarkable change except that the cervical end of the spinal cord is attached to the scalp near the occipital region. No pineal body is observed.

DISCUSSION

The autopsy findings in one set of anencephalic twins confirm some of the impressions of various observers in the literature and are in agreement with some of the experimental studies in animals. Of particular interest is the difference in bodily development of the two fetuses. The weight of the adrenals is inversely proportional to the weight of the two bodies.

Hereditary factors are probably the main cause of the anomaly. Differences in environmental factors must be present to account for the variations described in presumably identical twins.

SUMMARY

1. A case of anencephaly in identical twins is reported. It is believed to be the second fully reported case in the literature.

2. The diagnosis was made four weeks antepartum by means of roentgenographic examination.

3. The literature dealing with the etiology and pathogenesis of anencephaly is reviewed.

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THE ROENTGEN FEATURES OF MUSCULAR DYSTROPHY*

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THIS report is concerned with the roentgen features of muscular dystrophy as seen by us over a period of fifteen years in 35 patients. Our material consists mostly of advanced cases, requiring institutional care. Muscular dystrophy is a disease of unknown origin, affecting the myoneural junction and resulting in the progressive wasting of the musculature. Sometimes it is associated with pseudohypertrophy of the affected musculature. The larger muscles of the shoulders, pelvic girdles and the hips are, as a rule, first affected, and the smaller muscles of the hands and feet are usually affected at a later stage of the disease. The disease usually follows a definite pattern in this fashion. Occasionally an atypical course is seen because of affection of variable groups of muscles, and names are attached to the disease adding to the confusion of terminology, since they thereby designate a certain anatomical distribution. The disease begins, as a rule, in early childhood. It may, however, occasionally start during adolescence or late puberty. It is occasionally seen in adults. It is more frequent in boys than in girls.

For our purpose, the myopathies can be divided into two main groups, the pseudohypertrophic muscular dystrophies and the muscular dystrophies. The disease is primarily an affection of the muscles, and changes within the muscle proper are the main roentgenographic feature. These changes are quite characteristic roentgenographically and practically permit the diagnosis of muscular dystrophy on that basis. The main pathological change in the muscle, which can be recognized grossly as well as histologically, represents abundant replacement of the muscle tissue by fat. The muscle becomes yellow and is easily recognized as such. Fat appears roentgenographically as transluscent bands and can be demonstrated in the extremities as transluscent shadows within the muscle fascia. When we first observed fat in the muscle, we assumed that subcutaneous fat would be a disturbing factor in evaluating this finding. The differentiation, however, was not difficult. Normally, fat is not seen within the muscle proper but is present at the insertion of the muscle tendon. Upper and lower extremities lend themselves very well to the demonstration of fatty tissue within muscle. The extent of the disease can be assessed from the amount of fat deposited, and, conversely, the amount of fat present depends on the stage of the disease. In the more advanced cases, there is almost complete replacement of the muscle by fat. Fat is deposited within the muscle in the direction of the main tendon. Degeneration of the muscle tissue with replacement by fat tissue takes place in other diseases such as infantile paralysis, etc. Roentgenographically, however, there are two distinct features to differentiate fat in muscular dystrophy from other diseases. When fat is present in other neurological disorders, it is associated with a shrunken muscle. The muscle is decreased in size and contracted. The amount of fat is never excessive, and the amount of subcutaneous fat is invariably increased. Soft tissue roentgenograms are required for proper interpretation of these findings. They can be readily produced by mainly employing low kilovoltage and increased target skin distance. It is not surprising that such a striking appearance of muscle has been recognized before. Frantzell utilized a case of muscular dystrophy in demonstrating the value of soft tissue roentgenography, and

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Becker reported a similar observation in the German literature. It is possible to estimate, on the basis of the fat replacement, the residual functional capacity of the muscle. There is one entity where fat deposition is as abundant as in muscular dystrophy. It is seen in arthrogryposis, an obscure pediatric entity of congenital origin. In this latter condition, however, muscle planes are either absent or reduced in size. Muscle volume in muscular dystrophy is either maintained, and as the disease progresses is replaced by fat, or the muscle volume is increased in the pseudo-

Fig. 1. Histological section of muscle in progressive muscular dystrophy, taken from M. Vastus Medialis. There is marked replacement of the musculature by fat tissue. ×150. Low magnification. Deposition of fat will appear as translucent bands on the roentgenograms.

Fig. 2*A*. At the age of eight. Note the relatively normal muscle density with little fat deposition in the gastrocnemius muscle. Patient was able to walk with a waddling gait at that time. Relatively little weakness in the lower extremities. Marked weakness in the upper extremities.

FIG. 2*B*. Same case nine years later when the disease is markedly advanced. Muscle volume has been maintained. There is excessive deposition of fat within the muscle which appears as translucent bands. No increase in subcutaneous fat. There is flexion contraction of the knees. Note also that in the nine years there is no increase in the growth of the width of the long bones, whereas growth in length has taken place. This is referred to as concentric atrophy.

hypertrophic form and constitutes the bulk of soft tissue.

Second in importance to the involvement of the musculature is the involvement of the osseous system. Roentgenographic studies of the lower extremities frequently demonstrate the femurs to be the width of a phalanx and surrounded by a bulky soft tissue mass. This has attracted attention, and has given rise to a number of reports in the literature, usually referring to bone involvement in muscular dystrophy, which has been sometimes referred to as osseous dystrophy. It is seen only when the disease starts at an early age, prior to the closing of the epiphyses and during that period of time when active growth in length of the bone is present. This reduction in width is referred to as concentric atrophy. It consists of a reduction in width of the medullary canal of any long bone. The cortex is also reduced in width but is less affected. Concentric atrophy of the bone is commonly found in any disease which permanently affects any part of the afferent or efferent nerve supply of the muscle or muscles in the child at an early age. With normal epiphyseal development the bone can grow in length, but the growth in width depends on the stimulus and activity of healthy muscle. If the muscle power is impaired either by disease of the muscle proper or by disease of the nerve supply, the bone remains frail. Consequently, one may see a similar bone appearance in adolescents with a flaccid paraplegia, and in

Fig. 3*A*. Development of the pseudohypertrophic form of muscular dystrophy. This film shows the upper extremities at the onset of the disease at the age of eight. In this case, there was at first marked involvement of the lower extremities with little involvement of the upper extremities.

cases of infantile paralysis, where there has been complete loss of function of an extremity at an early age. Furthermore, aside from neurological diseases, as in infantile paralysis, where it is common, Still's disease, which is rheumatoid arthritis in children, will show the same features in the long bones. In reviewing the case records in the literature which show the same findings as our patients, the age of onset is always early. It is not the amount of muscular dystrophy which controls this appearance of the bone. In advanced cases of muscular dystrophy with a late onset, the width of the bone is normal and no concentric atrophy is seen. In these patients, however, if dystrophy is advanced, marked osteoporosis is present. If concentric atrophy has taken place, osteoporosis is not a predominant feature. The epiphyseal areas are less affected by the concentric atrophy and the epiphyses show osteoporosis whereas the shaft has a relatively normal bone density. The feature which all cases showing concentric atrophy have in common is the age of onset, which we believe explains this phenomenon.

Aside from the long bones, secondary affection of the joints with development of contractures takes place. These contractures are produced by assumption of fixed positions for long periods of time. Another feature responsible for the contractures is the associated fibrosis of the muscle which results in shortening of tendons. However, contractures are mainly seen in the lower extremities, affecting the knees and ankles, which would place main emphasis on position as responsible for the contractures. In addition to the involvement of the long

FIG. 3*B*. Nine years later. Note the increase in muscle volume which is made up by fat deposits. There has been no increase in subcutaneous fat. Note also the growth in length of the humerus where, again, there has been no increase in width. At this time, there is complete loss of function of the upper extremities.

FIG. 4. Feathering of the gastrocnemius. The fat is deposited within the fibers in the direction of the tendon insertion. The muscle is clearly delineated from subcutaneous fat. Also contractures of the knee.

Fig. 5. To contrast the fat deposition in diseased muscle with a healthy muscle in an individual who is markedly obese. This is a case of Weber-Christian syndrome, and soft tissue roentgenograms also portray the presence of nodules within the fat tissue. The excessive amount of subcutaneous fat is shown. The amount of subcutaneous fat has nothing to do with fat deposition in the muscle.

bones, there is usually involvement of the spine because of the weakness of the trunk musculature. Since the disease affects the musculature bilaterally and is evenly distributed, a marked scoliosis is seen to the right. Scoliosis of the dorsal spine when due to intrinsic spinal disease or as a result of postural defect is to the right. There is, however, an occasional scoliosis to the left in muscular dystrophy. If there is involvement of the dorsal as well as the lumbar spine, a uniform C-shaped curve is produced. Rarely is there an S-shaped scoliosis. Because of the muscular wasting within the shoulder girdle area, the scapulae appear to be winged, and with an early onset of the disease, the scapulae frequently show concentric atrophy.

Postmortem examination will show involvement of the heart musculature by the same pathological process with deposition of fat, degeneration of the muscle fibers and replacement by scar tissue. To a limited extent, replacement of the smooth muscle within the intestinal wall of the small intestine by the same process is also seen.

Roentgenoscopic examinations as well as roentgen kymographic studies will show decreased amplitude of the pulsations of the heart. Electrocardiographic studies are, however, much more reliable in demonstrating cardiac involvement. Enlargement of the heart chambers as a rule is not seen. Gastrointestinal involvement, which is noted on postmortem examination, is not demonstrable by our methods of examination of the intestinal tract. Gastrointestinal examination and small intestinal studies

FIG. 6. Still's disease. Concentric atrophy of the bone due to early contracture of the joints with secondary muscle atrophy, interfering with the normal development of the bone in width. Similar appearance of bone changes in muscular dystrophy, infantile paralysis and spina bifida, depending on early onset of the disease.

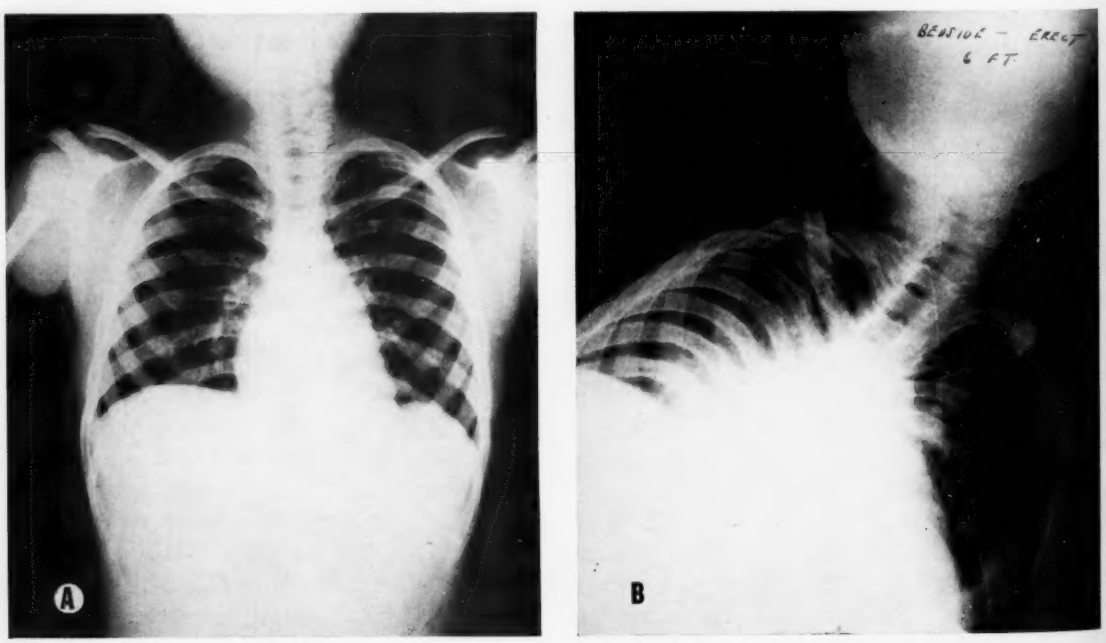

FIG. 7. (*A*) Development of kyphoscoliosis of the spine within a period of ten years. This film shows findings at the time of admission. (*B*) The same patient ten years later.

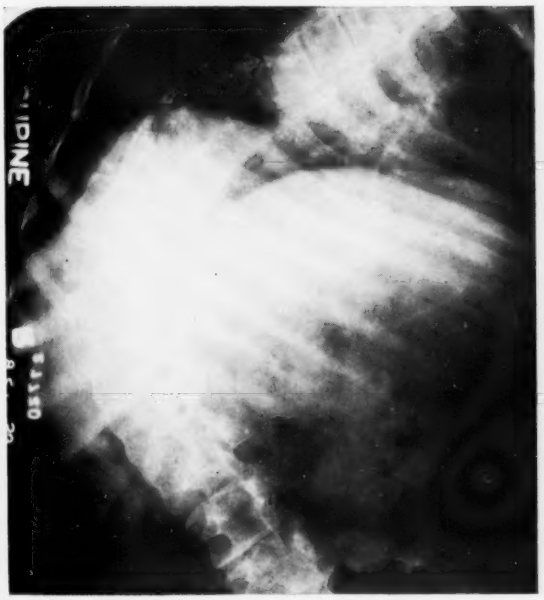

FIG. 8. Marked scoliosis of the lumbar spine with a uniform curve toward one side. Typical example of the scoliosis formed in muscular dystrophy.

FIG. 9. Hypertrophic muscular dystrophy The hypoplastic appearance of the femur in contrast to the bulky soft tissue mass. Very advanced case with onset at the age of six.

FIG. 10. Typical example of muscular dystrophy showing marked feathering within the muscle, due to fat deposition. Minimal osteoporosis is present. Onset of the disease at the age of twenty.

fail to disclose significant changes, or changes which are specific or constantly seen. The esophagus, as a rule, will show diminished peristalsis. The most important involvement is the involvement of the diaphragms which occurs late in the disease, manifesting itself by limited excursions of the diaphragmatic leaves. The basal segments of the lungs are not well aerated because of the weakness of the diaphragms and of the chest muscles. Once involvement of the diaphragm takes place, aspiration pneumonitis is common. The most frequent cause of death in muscular dystrophy is basal pneumonitis. With the aid of mechanical respirators and antibiotics, this cause of death has been delayed. Basal atelectasis is a frequent occurrence and it is possible to eliminate areas of atelectasis by oxygen inhalation. Genitourinary involvement is uncommon in muscular dystrophy. Sphincter control remains good.

SUMMARY

1. Muscular dystrophy is a disease of the myoneural junction of unknown origin, giving rise to characteristic deposition of fat in the affected musculature.

2. The excessive amount of fat is recognized as translucent bands and show characteristic feathering recognized roentgenographically. The bones in the affected extremities show osteoporosis or concentric atrophy, the latter depending on the age of onset of the disease. The bone changes are purely secondary to the muscle involvement.

3. The disease is progressive, giving rise to scoliosis of the spine and contractures of the joints.

4. Involvement of the diaphragms is common. Involvement of the diaphragms and cardiac muscle may be recognized roentgenographically. Basal pneumonitis is frequently the cause of death, in the advanced cases, and is usually secondary to the involvement of the diaphragms.

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A RARE CASE OF RACHISCHISIS WITH MULTIPLE MALFORMATIONS*

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AMONG the congenital malformations of the vertebral column the dysraphias take up an important place. The one which we had the occasion to observe was that of a newborn which appeared to us to be an exceptional kind.

There is nothing in the antecedents of this child who has one sister who is in good health and who bears no malformation. The parents of the child are perfectly healthy and there is neither consanguinity nor syphillis nor alcoholism. No disease occurred during pregnancy. The child was born at term on July 7, 1949, in breech position. It weighed 3240 gm. and measured 47 cm. It was pale and spastic and at once gave a bad impression (Fig. 1).

The reflexes of the lower extremities, which were normally formed, showed no disorder. However, the baby showed numerous malformations; one of which, a hydrocephalus, is visible in Figure 1.

In Figure 2 one can clearly distinguish two areas on which the teguments are absent. The first one is situated in the inferior dorsal region and consists of a meningomyelocele covered by a reddish peel; it is oval shaped and well delimited with its long axis longitudinally directed (7 by 3 cm.). It is separated from another area by 2 cm. of healthy skin. This area is situated in the sacrolumbar region and is characterized by an elongated gutter with a clear cut limit measuring 4 by 2 cm. Examining it more carefully, we find that there is a groove at its superior part, not deep, parallel to the vertebral axis, which communicates with a small orifice from which flows a bit of meconium. This continues right through the groove which is covered by rectal mucosa, as confirmed by histopathological examination, and in the folds of which there is a small polyp implanted which was found to be aberrant adrenal. No nervous element is to be seen and the nerves of the cauda equina are invisible. The possibility of thrusting one's index finger into the tissues without encountering any resistance permits us to suppose that the sacrum is absent.

The urinary meatus is in its place; apparently there is neither penis, nor clitoris, nor vagina. Nevertheless one seems to be able to affirm the presence of the labia majora and the labia minora both of which are hypertrophied, the former being grayish with a grainy surface, the latter red-violet and smooth.

During its brief existence the child remained afebrile; it fed badly, and breathed with ever increasing difficulty until it died after three days.

Such lesions should, it seems, be accompanied by malformations of the skeleton. As we shall see they revealed themselves to be much more important than might have been supposed.

This first roentgenogram (Fig. 3), taken in the anteroposterior position, shows that the vertebral column describes a slight scoliosis with a right concavity in the inferior dorsal region which widens progressively forming two branches, giving it the aspect of a Y turned upside down.

The bodies of the vertebrae, which are normal down to the 6th thoracic, seem to be altered from T6 onward showing an outline of a division on the midline. Flattened and partially united, T7, T8, and T9 form a block in which the intervertebral discs are aplasic.

This leads us to believe that the widening at the level of the inferior thoracic column is probably a faulty fusing of the spinous processes. The entire sacrolumbar spine gives the impression of being a double column, as if the vertebrae had split into two halves which turn away from each other in order to be brought together again without, however, joining in the middle, thus forming an arc of a circle. The right column, the more important

* From the Department of Radiology, Faculty of Medicine, University of Lausanne. Chief of Service: Prof. A. Rosselet. Presented at the Sixth International Congress of Radiology, London, July, 1950.

FIG. 1.

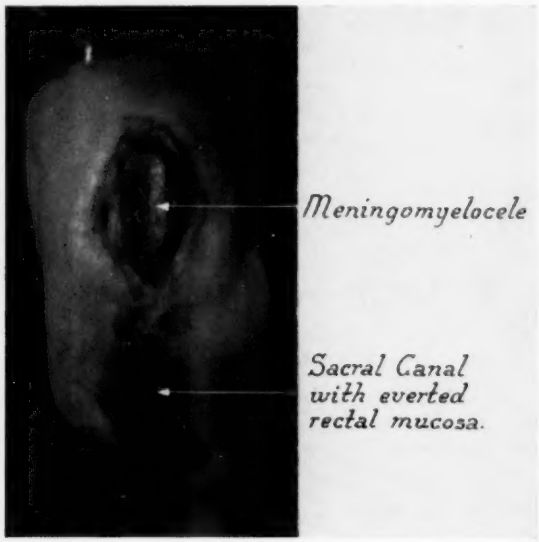
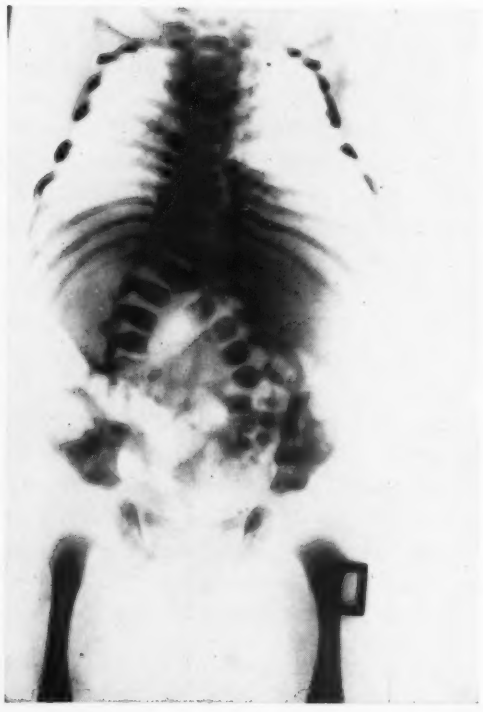


FIG. 2.

one, comprises widened lumbar vertebral bodies which are situated farther down than the ones on the left side. S1, S2, S3, and S4 are irregular. On the left side only the four first vertebrae of polymorphic appearance are roentgenologically visible. Seen in profile it is striking to find that the vertebrae can be seen on the left as well as on the right side.



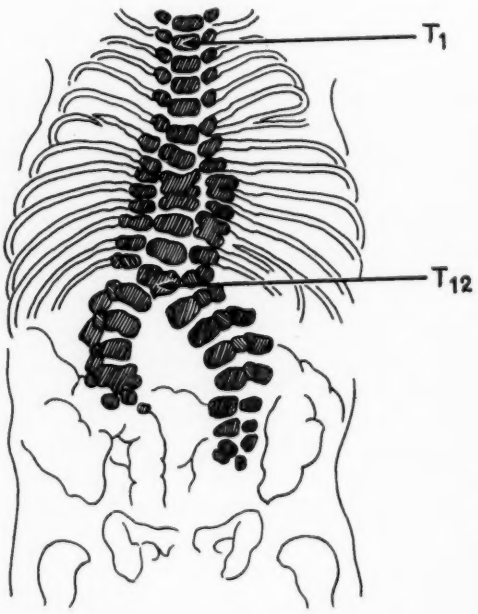


FIG. 3

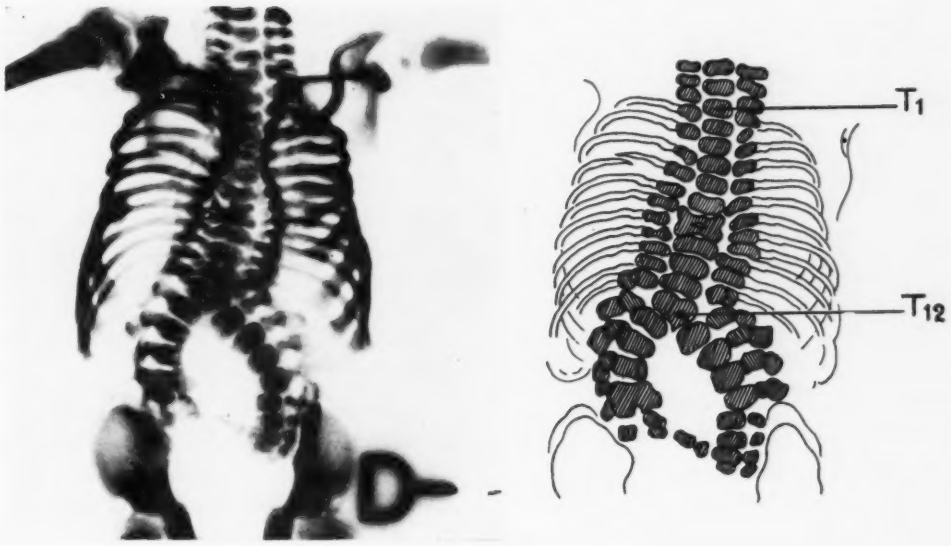


Fig. 4

The examination of this roentgenogram permits us to consider the possibility of two complete lumbar columns or two half-columns facing each other in the frontal plane after having performed a rotation of 90 degrees.

We only mention, by the way, a few costal anomalies.

At autopsy the child turned out to be of masculine sex, the scrotum originally considered to be the labia majora, contained atrophic testicles, a condition described under the name of androgenous pseudohermaphrodism. There were no other visceral alterations except for the opening of the sigmoid into the superior part of the groove described above.

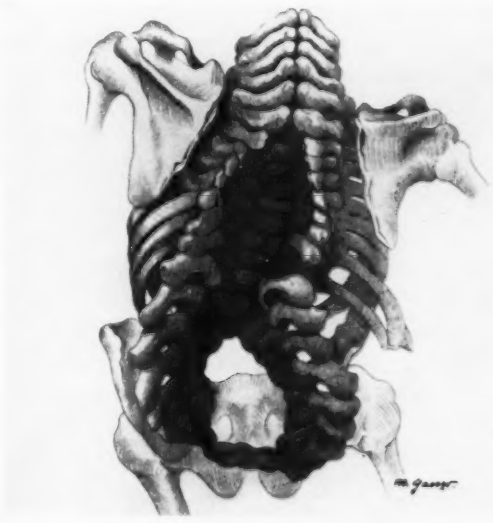


Fig. 5. A drawing of the prepared skeleton. Posterior view.

Figure 4 is a roentgenogram of the stripped skeleton; it partly confirms our first description but we were surprised to find that the two segments of the spine join each other in their terminal part taking the form of a bridge which comprises the three first left sacral hemivertebrae. There are no coccygeal vertebrae. The sacroiliac articulations are replaced by homologous articulations between the iliac crests and the two first sacral hemivertebrae. The ischiopubic branches join in a normal symphysis (Fig. 5).

A meticulous dissection allowed us to confirm the integrity of the posterior vertebral arch down to T3; it also showed that the widening of the spine at the level of the inferior thoracic column did correspond to a deficient fusion of the spinous process as well as to the opening of the spinal canal which grew progressively more marked as far as T12. As the roentgen examination lets us presume, each lumbar half-column drawing the posterior demi-arch which is attached to it, in a rotation

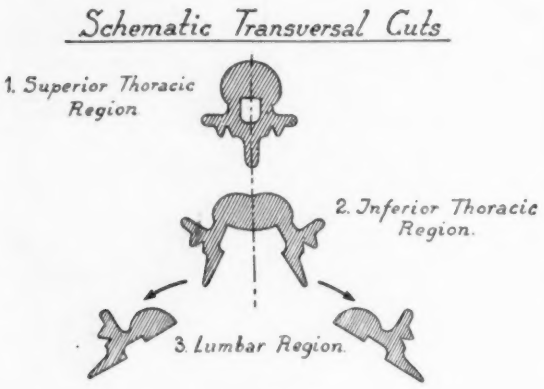


FIG. 6

from inward toward the outside, has placed the spinous process laterally, the crests of which serve for the attachment of the dorsal muscles.

There was one single spinal cord of normal constitution as far as T3; farther down where the spine is opening, it spread out forming a meningomyelocele but instead of terminating in a filum terminale, it continued to spread in a kind of sheath of neuroglia resting on the dura mater which filled up the hiatus between the two half-columns. This sheath was limited on either side by elements of the cauda equina which normally come out by the interspinal foramina.

Thus dissection confirmed our second roentgenological hypothesis, *i.e.*, the existence of one single sacrolumbar spine divided into two.

The anomaly is illustrated schematically by transverse sections at three levels (Fig. 6).

It is well known that beginning from the first days of intrauterine life, parts of the somites, the sclerotomes, come to lie alongside the notochord. The anterior and posterior parts of these proliferate actively, fusing in front and behind on the midline and finally closing in on the neural tube in order to form the membranous column. Seen anteroposteriorly the outline of the vertebral body is the result of the fusion of the two anterior halves of every sclerotome, whereas that of the vertebral arch comes from the two posterior halves. It must therefore be admitted that through a faulty development whose origin cannot be traced and the mechanism of which escapes our knowledge, this fusion did not take place in the posterior part of the embryo where metameric disorders occurred, explaining the non-correspondence of the sacrolumbar hemivertebrae. An anomaly of that extent could hardly be explained by a defect in chondrification or ossification.

When we thought of the possibility of two complete lumbar spines, we were permitted to consider a particular form of double monster and to suppose the previous existence of two spinal cords and two notocords having induced two columns.

We shall refrain from going into the details of the other anomalies which the child presented; let us say only that the meningomyelocele and the rectal exstrophy can be explained by an identical mechanism, the defective closing of the neurenteric canal.

And now, what suitable name might be given to such a malformation which, as far as we know, has not been object of any previous publication?

The two words usually employed to designate vertebral dysraphias—spina bifida and rachischisis—are often given different meanings.

Spina bifida designates a defective fusion of the spinal canal; it concerns, etymologically speaking, only the posterior vertebral arch. It is most often present in the lumbar region and said to be aperta or occulta, according to whether or not it is accompanied by a hernia of the spinal cord and its coverings. To Schwalbe the word rachischisis means a posterior opening of the vertebral canal with a spreading of its contents, and for Koch it is a spina bifida stretching through the whole length of the spinal column.

The interest of our observation lies in in the fact that the anomaly concerned not only the posterior arch—thus realizing the picture of a spina bifida—but the vertebral body which is equally divided in a sagittal plane into two independent halves far removed from each other, correspond-

ing to a particular form of somatoschisis.

There is good reason to reject the term anterior spina bifida to designate a split of the vertebral body and we should also not speak of anteroposterior or total spina bifida. Allowing the word to assume another sense, we consider this anomaly consisting of a spina bifida and a somatoschisis as a veritable rachischisis. We agree with Putti that this word, taken in the sense of an anteroposterior total scission of the spine in a median sagittal plane and not only posterior scission down the whole length of the column, construes best the particular character of the malformation. In order to be precise we shall speak, therefore, of anteroposterior sacrolumbar total rachischisis or of a double sacrolumbar column . . . provided it is not one of those monsters which it is impossible to classify in a well established nosology, and of which Pliny said some time ago: "Nature creates in order to astound us and to divert herself."

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Vol. 73, No. 2

CONTRAST MEDIA AS A DIAGNOSTIC AGENT

REPORT OF THREE UNUSUAL CASES

By LEWIS J. FRIEDMAN,* RICHARD M. FRIEDENBERG,† *and* JERROLD S. LIEBERMAN‡

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ANGIOCARDIOGRAPHY at the present time is an expensive roentgenographic diagnostic aid because of the necessity of a rapid cassette changer for serial exposure in following the course of contrast medium through the vascular channels. When an automatic apparatus is not available an inexpensive manual changer may be used with satisfactory results.

In 2 of the cases described below, a cassette changer similar in detail to the one described by Henry K. Taylor[9] in 1949 was used for angiocardiography. Ours was manually operated. The third case involved a peripheral angiogram.

Angiocardiography. In this technique the usual procedure is followed by taking two standard films, one posteroanterior and one oblique, by which positioning and exposure can be checked. One member of the team rotates the cassette changer, the second gives the injection, and the third, using a stop-watch, exposes the films. If desired, the four films can be taken in ten seconds. We have used two injections routinely, enabling us to obtain views in two positions.

In a series of 15 cases 75 per cent neo-iopax* has been used without serious untoward reactions. Flushes, dizziness and nausea were occasionally observed. The injection time, using a Robb-Steinberg syringe and needle, has been one to two seconds. Exposure factors were 300 ma. at 1/15 to 1/20 of a second, using 75 to 90 kv., depending on the size of the patient and the position desired. In general, about 10 kv. additional to that used for routine chest films was found satisfactory.

In *arteriography* of the extremities 35 per cent neo-iopax was used with a sphygmomanometer inflated to systolic pressure distal to the site of injection. Ten to 15 cc. of the opaque medium was rapidly injected, the exposure being made just before completion of the injection to insure some reflux above this site. In most cases two injections were made, enabling us to obtain views of the vessel in two positions.

REPORT OF CASES

CASE 1. S.G., Negro male, aged thirty-eight, had undergone a routine pre-employment roentgenographic examination, when a left-sided parahilar mass was found. There were no symptoms referable to the chest; the second pulmonic heart sound was loud and tambourlike.

Physical Examination. Bronchoscopy and esophagoscopy were within normal limits. Roentgenogram of the chest revealed a large parahilar mass on the left which on roentgenoscopy was seen to be anterior to the heart and pulsating. Angiocardiography three seconds after injection of neo-iopax, disclosed the above-mentioned mass to lie in the region of the pulmonary artery just below the aortic knob (Fig. 1). The left pulmonary artery is delineated by the neo-iopax whereas there is no evidence of contrast material within the mass itself. In the oblique projection, the right heart, pulmonary artery, and right and left branches of the pulmonary artery are readily visualized, with the mass "sitting" on the pulmonary artery and depressing its superior border (Fig. 2). Roentgen diagnosis: Extrinsic tumor mass compressing the pulmonary artery. At operation a mass was disclosed immediately beneath the pleura extending into the left anterior mediastinum. The neoplasm was approximately 8 by 10 by 4 cm., smooth and well encapsulated. It lay in the interval between the left pulmo-

* The neo-iopax used was furnished by Schering Corporation.

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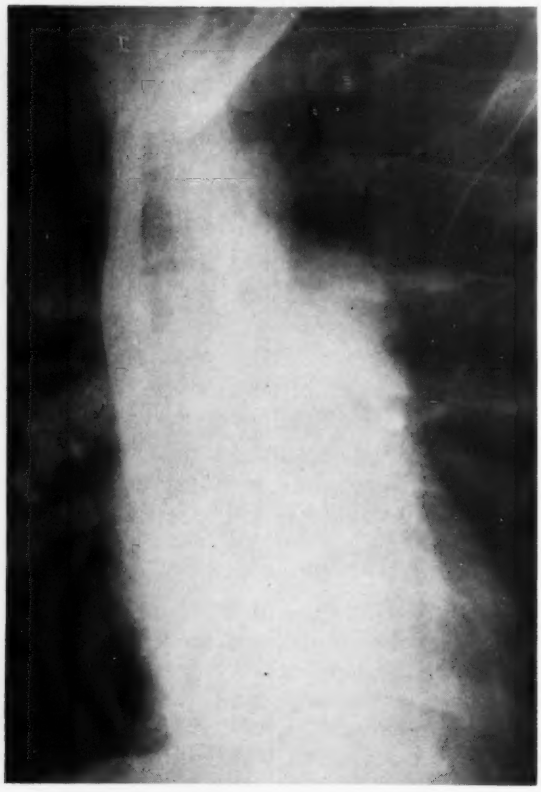

FIG. 1. Case I.

FIG. 2. Case I.

nary artery at its exit from the heart and the curve of the aortic arch above. There was no evidence of invasion of contiguous tissues. Pathological examination revealed the tumor to be a benign thymoma. The benignity of the tumor was suspected because of the smooth contour of the depressed section of the artery without evidence of invasion of the arterial wall.

CASE II. G.C., Negro male, aged fifty-six, had swelling of the left arm and shoulder and tenderness of the left axilla for two days prior to admission. Examination revealed marked enlargement of the left arm and left side of the neck, and marked tenderness and swelling in the left axilla and infraclavicular fossa. A short systolic and high pitched diminuendo diastolic murmur were heard over the aortic area. Blood pressure was 220/110 in both arms. The left arm and forearm were considerably larger than the right, the left measuring 33 cm. at the biceps, the right 26 cm. Moderate venous distention was noted in the left arm. Examination of the blood and urine revealed a 4 plus Mazzini, and negative Wassermann reaction. Venous pressure in the left arm was 500 mm. saline while that in the right arm measured 130 mm.

The patient was first examined in the postero-anterior and left anterior oblique projections using 75 per cent neo-iopax injected into the antecubital vein. The ascending aorta measured 48 mm. which was about 10 mm. above the normal range established by Dotter and

FIG. 3. Case II.

Steinberg. There was a saccular aneurysm of the distal portion of the arch of the aorta (Fig. 3). Because of the clinical symptoms of venous obstruction, the patient was re-injected several days later with 35 per cent neo-iopax in the left antecubital vein, the cassette centered over the arm. Figure 4 depicts a film taken three seconds after the injection. The cephalic, basilic and axillary veins are shown with their ramifications. There is a constant defect in the region of the axillary vein with numerous engorged radicles distal to this area. This defect was also seen on the last film taken at eighteen seconds and is thought to represent a thrombus within the axillary vein.

Case III. P.S., white male, aged twenty-nine, who had known heart disease for ten years. About six months before admission, he noted gradually increasing weakness accompanied by dyspnea on exertion, a 15 pound weight loss, swelling of the ankles and a transient episode of tender swollen finger tips. On admission, the patient had slight elevation of temperature, blood pressure of 190/80, pulse 96, and regular. The heart was enlarged, with murmurs, indicating mitral stenosis and insufficiency and aortic stenosis and insufficiency. The liver was felt below the right costal margin and the spleen was markedly enlarged. The fingers and toes were clubbed. Admission diagnosis was subacute bacterial endocarditis. Laboratory tests revealed a red blood cell count of 3.8 million with normal white blood cell count and differential; sedimentation rate 75 mm. (Westergren). The urine was free of albumin and sugar but repeatedly contained red and white blood cells. Of twenty-two blood cultures, one grew *Streptococcus viridans*.

Fig. 4. Case II.

Fig. 5. Case III.

The patient was placed on a regimen of 8 million units of penicillin per day for six weeks. On the day after the completion of therapy, he had an episode of chest pain and generalized aching pain with fever to 103° F., followed later by warmth, tenderness and swelling of the right leg with a positive Homan sign and swelling and pain in the right groin. On a regimen of anticoagulants, penicillin and local therapy, the thrombophlebitis subsided and the patient left the hospital against advice. He returned three days later with persistent tenderness and swelling of the right leg and knee. This was

FIG. 6. Case III.

followed by the development of a pulsating mass in the right thigh.

The patient had two injections into his femoral artery just above the pulsating mass, films were taken in the anteroposterior and the oblique positions. The film in Figure 5 shows the contrast material apparently within two loculated aneurysms arising from the junction of the profunda femoris artery. At operation a single large aneurysm was removed together with a segment of the femoral artery and profunda femoris. The appearance of the loculation was probably caused by two large thrombi found within the aneurysm. Pathological diagnosis of the surgical specimen was "mycotic aneurysm with thrombosis." A segment of the saphenous vein was interposed between the severed ends of the femoral artery to establish continuity. Following the operation, a second angiogram was taken (Fig. 6), showing excellent patency of the femoral vessel with slight constriction at the site of anastomosis of the venous graft.

CONCLUSION

Three cases depicting a mediastinal tumor, axillary vein obstruction, and mycotic aneurysm following subacute bacterial endocarditis are presented with appropriate illustrations.

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THE FUTURE OF THERAPEUTIC RADIOLOGY*

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PERHAPS one might think that from the title of this paper that a discussion of ultra-modern devices such as a 300,000,000 electron volt betatron, a giant cyclotron, and the multi-billion bevatron, would be presented. The purpose of this paper is to stress the need for radiologists to take time out to completely re-appraise the situation as it pertains to them, to reset their sites, and to plan accordingly.

Great strides have been made in radiology since the discovery of the x-ray by Wilhelm Conrad Röntgen in 1895, by J. J. Thompson's isolation of the electron in 1897, by the discovery of polonium and radium in 1898 by the Curies, and by the accidental discovery of the effect of radium on the skin by Becquerel in 1901. The number of advances that have been made since that time are too numerous to mention here.

Continued demands have been made by the medical profession for more efficient and more powerful roentgen-ray machines, for more advanced equipment for use for rotation, and for the medical application of isotopes.

Surgery and radiation, either singularly or in combination, are not the final answer to the cancer problem. Many cures and excellent palliation by both methods of therapy have been obtained. The management and treatment of cancer is predominantly a radiological problem because sooner or later about 75 per cent of cancer cases are seen by radiologists, especially for palliative therapy. Although the cause of cancer is not known, it does not necessarily follow that when the cause is found the cure rate of existing cases will be materially affected. The cause of tuberculosis has been known for many years but there are still many difficult problems in its management and therapy. It is quite possible that the cure of cancer may be found in the next fifteen or twenty years as a result of the tremendous amount of research which is being pursued, but until that time our task in therapeutic radiology is clearly cut out, namely, to do the best job we know how with the equipment we now have.

It is not necessary for one to be surrounded by expensive instruments, equipment, and ultra-modern devices to become an outstanding radiologist. We have only to think of great strides in radiology such as those made by the late Gösta Forssell, who founded the Radiumhemmet in small rented quarters and began that great institution with one roentgen-ray machine and 120 milligrams of radium. For anyone endowed with courage, vision, persistence and singleness of purpose, nothing will be impossible. A great deal of excellent work is being done in one-room laboratories with a moderate amount of good equipment. Future great medical discoveries may just as well come from these unpretentious laboratories as they have come in the past.

Garland has stated that "Irrespective of the radiation equipment available, it is the training and experience of the radiologist which is of primary importance:" he is the "facility!" At the risk of being tautologic I would repeat these words: "A knife never cured a cancer—a surgeon using a knife cured it. Conversely a roentgen-ray beam never cured—a radiologist using it did."

One is impressed by the fact that many radiologists have failed to realize that they are physicians practicing radiology. Many radiologists have treated patients accepting the referring physicians' diagnoses without taking adequate histories and doing physical examinations, and have failed to check the pathological slides. In so doing radiologists who pursue this course have lost con-

* From the University of California at Los Angeles, School of Medicine, Los Angeles, California. Presented at the Thirty-fifth Annual Meeting, American Radium Society, St. Louis, Mo., April 20–22, 1953.

tact with clinical medicine to such an extent that they have lost some of the respect of the surgeons, internists and other specialists. Radiologists are called by many merely "x-ray men" or "glorified technicians." Many of the laity and even hospital authorities have come to look upon the services of radiologists as that of a glorified technician. For this viewpoint in many instances the radiologist is to blame because of his failure to take clinical histories and to examine the patients sent to him. If the patient has no personal contact with the radiologist he is prone to consider him in a different light from one who examines and discusses his case with him.

One of the principal reasons that patients with cancer submit to quack treatments is because of our failure to adequately care for and advise them.

Because of insufficient interest, initiative and vision some radiologists have indirectly facilitated the use of radium for therapy by surgeons and gynecologists who may not be adequately trained and instructed in the dangers of its use both to themselves and to the patients. It is relatively easy for the radiologist to become familiar with the technique of the intrauterine insertion of radium and such operative procedures as are necessary for carrying out radiation therapy for gynecological lesions under sterile conditions. There is no reason why the radiologist cannot regain his logical position in radium therapy and work in close cooperation with the surgeon and the gynecologist. Everyone, and especially the patient, will benefit by this cooperative endeavor.

There is an increasing tendency for the use of isotopes to be taken over by nonradiologists. Here again part of the blame rests with the radiologist. The use of radioactive materials should be controlled and managed by radiologists and preferably by the therapeutic radiologist. The radiation physicists, working in close cooperation with the radiologist, will be available to all members of the medical staff for consultation, no attempt being made to deny anyone the use of isotopes when indicated but merely to safeguard both patients and personnel.

The radiologist who accepts a patient for treatment must assume his full share of the responsibility. He must devote as much time as is necessary for diagnosis, treatment and followup. He cannot and must not turn the patient over to a technician to treat. Economically perhaps there is less money and also more physical work involved in performing therapy. He must be completely familiar with the natural life history of the different types of tumors, of the pathology, of medical and surgical procedures, and of therapeutic radiology as it is applicable in the treatment of the various tumors. One does not frequently find adequate facilities for doing physical examinations, dressings, and follow-up clinical studies in the offices of the radiologists.

At the present time great emphasis is being placed on radiation physics. This is very good but as time goes on there is an increasing tendency to become more and more highly specialized, to devote more time to laboratory tests and procedures, and less time to the taking of a history and doing a careful physical examination of the patient. Often at tumor board conferences I have heard opinions given at great length as to what the treatment should be of a given case before the patient was actually examined. After the careful examination of the patient an entirely different viewpoint was obtained. Desjardins has stated that "to a physicist a neoplasm is a mass of tissue. To him the differences in the natural history of different kinds of tumors, their tendency to metastasize early or late, the tissues or organs which are prone to be affected primarily or secondarily, and their great difference in sensitivity or resistance to roentgen rays or radium, mean very little. But to a therapeutic radiologist these biologic considerations should be at least as important as a penetration of the rays or as the number of roentgens that can be delivered to a certain depth in a certain number of days." It is highly desirable that

the radiation physicist be taught as much as possible about the clinical applications and principles of therapeutic radiology in order to make him a much more valuable member of the team. Radium therapy still remains to some extent an art as well as a science.

At the present time there are not enough radiation centers in this country and too few good radiation therapists. It is necessary that as soon as possible there be a division of radiology into the separate specialties of diagnostic roentgenology and therapeutic radiology. In medical schools and in large institutions there can be a chairman for administrative purposes for both departments and for the training program. There will still be a need to train radiologists in both diagnosis and therapy especially those who will go into smaller communities where it will be impossible to set up a separate therapy department. Also it is probably wise to train all radiologists in the fundamentals of both diagnosis and therapy and then in the first or second year of training he can make a choice and either specialize in diagnosis or in therapy. The fourth year of training is desirable because the resident can devote some of his time to learning sterile surgical technique for gynecological lesions and other lesions requiring radium or radon seeds, etc. Most of the radiologic teaching should be in the form of informal conferences and seminars rather than in formal lectures. In the large institutions and medical schools the resident is able to see many different types of cases and will be able to correlate all the data and will have the opportunity to confer frequently with his colleagues in other specialties. Although some might consider four years as being too long to remain in institutional training in order to become a good radiation therapist this requires considerable experience as it can only be obtained by seeing and treating many patients and not by learning it out of a book. When to use surgery or radiation or both, or some other modality, requires experience and judgment and this cannot be obtained in a hurry. If the resident has only three years of training, six months of which is spent on pathology and part of the time on diagnostic roentgenology he will need many years in private practice to provide him with an adequate number of cancer patients to treat and study to enable him to obtain adequate experience and judgment. The successful treatment of cancer requires teamwork between the surgeon, the pathologist, the radiologist, internist, gynecologist, dermatologist, the radiation physicist, and all other specialties. Consultative tumor boards are of great value in helping determine which is the best treatment for a given case and particularly for complicated cases. Frequently one hears the remark that "he being a surgeon operated" or "he being a radiologist prescribed radiation." On many occasions I have presented patients to the tumor board with the idea that I had worked out a satisfactory therapy program. However, after discussion with other representatives of the board I have changed my opinion in order to provide more satisfactory treatment for a given case.

In the past there has been too great a tendency to refer only far advanced palliative cases to the radiation therapist. As soon as the radiation therapist has obtained the confidence of his colleagues by demonstrating to them the usefulness and success of radium and roentgen therapy when properly applied he is given more early small lesions to treat. It is regrettable that in some large centers aggressive therapeutic radiologists are not available in order to help round out the training program in those institutions.

Although the role of the therapeutic radiologist is devoid of the glamour associated with surgery, his rewards are just as great in doing good for humanity. He need not be unduly pessimistic but should think of the many far advanced cases of cardiovascular, cardiorenal, tuberculous, arthritic, and many other long drawn out crippling disabling diseases which other specialists care for. The therapeutic radi-

ologist is provided with many opportunities both to cure and palliate disease and he has enough cases with excellent results to keep him optimistic at all times.

SUMMARY

A plea is made for all radiologists to utilize their training as physicians first and as radiologists second. They should take histories and make careful physical examinations on all cases referred for treatment in order to maintain both the confidence of their colleagues and of their patients and in order to do better therapy.

Diagnoses and biopsy reports should never be accepted without the radiologist making his own study and analysis of the case.

The radiologist sees many cancer cases and is in a position to know the effects of the various methods of treatment whether used singly or in combination.

There should be a division of radiology into diagnostic roentgenology and therapeutic radiology. If the radiologist does only occasional therapy it is unlikely that he will devote the necessary time and effort to see that proper therapy is carried out and also he will not constantly keep abreast of what is new in the literature and may not attend the tumor boards in his vicinity.

Although the role of the therapeutic radiologist is devoid of the glamour associated with surgery his rewards are just as great in doing good for humanity. He need not be unduly pessimistic but should think of the many far advanced diseases which members of other specialties care for in which the possibility for cure is very small or nil.

Even with present methods of treatment at least one-third of the patients now dying from cancer could be saved with early diagnosis and adequate initial therapy.

Therapeutic radiology has made great strides during the past fifteen years and every possible effort should be made to continue to advance this essential specialty. There are many fields of investigation which need to be studied and there are many problems as yet to be answered. The future of therapeutic radiology is bright but we must be constantly vigilant and become better clinicians.

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DISCUSSION

DR. H. DABNEY KERR, Iowa City, Iowa. I would like to epitomize the thought which I get out of this statement by Dr. Stein by saying that the future of therapeutic radiology is in the hands of the therapeutic radiologists.

That includes, of course, his two main theses. One is (and this, of course, is a pet subject with me, as it is with most of you) that primarily we are physicians. The second (and one which I think he did not emphasize perhaps quite as much as he should have) is that if we don't put all that we've got into the subject of therapeutic radiology, that branch of our specialty will not only not go ahead but will regress, because there is a pressure from the surgical side. Our surgical confrères are doing everything they possibly can—and rightfully—to increase their results in the cure of malignant disease, whereas many of us sit more or less idly by and continue to do what we have done for the past ten or fifteen years or more.

I would not like to take any more of your time except to emphasize that the future of therapeutic radiology, as we now know of it—or as we can now conceive of it in the light of recent advances—lies in the hands of therapeutic radiologists, and if it falls by the way, we have only ourselves to blame. That is true not only of the ordinary therapeutic measures which we use—roentgen rays and radium—but also of the uses of isotopes. Many of these things have gone by default because of a con-

spicuous lack of interest on the part of therapeutic radiologists.

So, with those thoughts, which I would again like to emphasize, as they have been brought out by Dr. Stein, I would say again that if we continue to be more or less blasé and think that because certain conditions have been sent to us in the past they will continue to be sent to us in the future, we may be much disappointed, because there is always—and rightfully—a continued pressure, not of competition but continued pressure for better results from the surgical side. We cannot afford to be less forward-looking or less persistent than our colleagues, the surgeons.

DR. RALPH PHILLIPS, New York, N. Y. I guess I was asked to speak on this as bridging both sides of the Atlantic, and as an adopted American. I must say I don't agree with all this self criticism. I have been about this country a great deal, and I think the standards of therapy are extremely high here, particularly in the smaller centers. I think perhaps it is the big centers that are failing, but perhaps Dr. Kerr and all the rest of you know more about that than I do.

I certainly enjoyed Dr. Fricke's paper,* and I am sure he must have evoked pleasant memories in many of us.

There are one or two things in the English experience which I think may be applicable here. Certainly, one of them concerns the time when we founded the Society of Radiotherapists, because we got radiation physicists and radiation biologists as equal members. We also invited such surgeons, pathologists, and others, who were interested in cancer; we let them be honorary members; we didn't let them pay any dues, and they had no say in the society—they came to help, and not to govern.

There was another point Dr. Fricke brought out, and that was the education. Of course, it isn't only the post-graduate education that is different in England. It is different from the grade school on up. So far as medical education is concerned (and here I'd like to take issue with Dr. Stein) the tradition there is learning by osmosis and not by teaching.

I don't like teaching physicists or anyone else. I think it is the association—as Herb Parker brought out so well yesterday—and the cross-fertilization between minds discussing things on an equal basis, and demonstration by example, and not by dogmatic teaching, that has led to what really has been a remarkable growth of radiation therapy in England in the past twenty years.

As regards the future of therapeutic radiology, I haven't the faintest doubt myself. After all, when you think that the understanding and the investigation and control of cancer owes more to fifty years of radiotherapy than it ever did to five thousand years of surgery, you must believe that the next twenty-five years will see at least equal achievement. I do not see that there is any question of that promise not being fulfilled.

Radiotherapy must be mistress in her own house. She must be able to attract the very best intelligence and character to her service, and she can't do that as a subdivision of diagnostic radiology or surgery or any other specialty.

Just to conclude, I would like to recall words that are applicable in this instance to both the radiologist and the surgeon—there are many dangers awaiting those who use tools they do not understand.

DR. FOLKE JACOBSSON, Stockholm, Sweden. I am just talking from the Swedish point of view. In Sweden we have discussed the future development of radiotherapy very much. It has been of immense importance to us to have the radiological treatment of cancer centralized in three centers, each with its own defined region of population.

In cancer of the cervix, the majority of cases are still referred to the centers, because treatment with larger amounts of radium cannot be done in other places, and irradiation, in Sweden, is still recognized as the best treatment for this disease. As for cancer that can be treated with roentgen radiation, there has been an increasing trend for radiologists in county hospitals—without special training—to want to treat these cases, partly because they want to spare the patient a long journey to a center and partly, also, because the local surgeon considers that there is a roentgen-ray machine in the hospital, and a doctor who can prescribe the dose and run the machine. The surgeon doesn't realize that roentgen treatment can be performed in different ways with quite different results.

At the centers we are convinced that the radiation treatment of cancer ought to be centralized as much as possible. To overcome the

* Fricke, R. E. Comparison of radiotherapy abroad and in the United States. AM. J. ROENTGENOL., RAD. THERAPY & NUCLEAR MED., October, 1954, *72*, 666–669.

difficulties with long journeys and waiting time, we intend to create one or two new centers of the same type as the older ones.

A center ought to be equipped with not only a radiotherapy department but also a radiopathologist, a radiophysicist, a radiobiologist, and facilities for competent tumor surgery. To attract and interest competent doctors, it is of utmost importance that the economic conditions be good. Doctors training at these centers with the aim of devoting their lives to the cure of cancer have very few possibilities for advancement.

At the centers we earlier trained all radiologists in Sweden in radiotherapy for about one to two years. We think, however, that this training is too short for a radiologist to be able to treat all cases of cancer adequately. It may also be too long for radiologists who will only learn to treat nonmalignant diseases and advanced cancer cases and be consultants at the county hospitals as to which cases should be sent to the centers.

We now consider that it is better for the future of therapeutic radiology that radiologists who do not intend to specialize in radiotherapy should, above all, learn which cases they ought to send to the centers and which cases they ought to treat at the county hospitals. It is better to send too many cases to the center than to deprive a patient of the chance of cure with highly skilled men and specialized treatment. I believe the risk of centralization is defeated by the competition between independent centers.

As to the education of the radiotherapist, he must know almost more than any other specialist. Especially should he have good experience in internal medicine, and a good knowledge of the possibilities of surgery in cancer, and be able to follow the evolution in these specialties.

We are convinced at Radiumhemmet that our increasing improvement of the results, for example, in carcinoma of the hypopharynx is in a large part due to our facilities, to be able to have our own beds for these patients, and to be able to follow and care daily for their general condition.

We have been forced to learn the proper use of antibiotics, vitamins and the different agents, and the evaluation of the fluid balance.

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THE EFFECTS OF IRRADIATION OF THE PELVIS IN PATIENTS WITH CARCINOMA OF THE CERVIX UTERI ON THE ILIAC AND STERNAL MARROW AND ON THE PERIPHERAL BLOOD*

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PREVIOUS investigators have not been in agreement as to the degree and extent of the effects of irradiation on the bone marrow. Meller, Gottlieb and Brauner[10] indicated an effect on neutrophils within a few minutes after a dose of 28 roentgens, and stated that small doses of roentgen rays accelerate maturation and thus stimulate the marrow. Florentin and Binder[4] described decrease in the erythrogenic and myelogenic cells of the sternal marrow during exposure of the sternum to therapeutic irradiation and suggested that this effect was partly responsible for changes in the peripheral blood. Piechl[14] concluded that irradiation to parts of the marrow other than the sternum had no effect on the sternal marrow.

The purpose of this study is to determine the effect of local irradiation in therapeutic doses on the adjacent and distant bone marrow. The opportunity for this type of investigation was supplied by 12 patients with carcinoma of the cervix uteri who were receiving therapeutic irradiation to the pelvic organ.

MATERIAL AND METHODS

The plan of study involved sampling of the bone marrow before treatment, and after therapy with both roentgen rays and radium. Twelve consecutive patients with carcinoma of the cervix proven by biopsy (Table 1) submitted to the experiment.* Samples of bone marrow were obtained before, and at varying intervals after the initiation of roentgen therapy in 10 patients. In only 2 of these patients (Cases 6 and 7) were samples of the marrow obtained after treatment with radium as well as after roentgen therapy. A single specimen of bone marrow was obtained in Cases 11 and 12.

Hemoglobin levels, hematocrit values, erythrocyte and leukocyte counts, and smears of the peripheral blood were obtained at the time of the initial aspiration of the marrow. When possible, leukocyte and differential counts were made daily while the patient was treated with roentgen therapy. Hemoglobin determinations were performed using the Cenco photelometer and blood was drawn in ordinary clinical pipettes for cell counts.

Before the initial roentgen treatment or within twenty-four hours after it, bone marrow was aspirated from one iliac crest. At the time of implantation of radium, samples of marrow were removed from the opposite iliac crest and the sternum. As Table 1 shows, the time at which radium was implanted varied in the individual patient. Marrow samples were prepared according to the method of Berman[1] as well as that of Schleicher.[18]

Since it is generally considered[9,15,17] that an adequate sample of marrow aspirated from one site is representative of the composition of marrow from other sites, the samples obtained from the initial aspiration of the iliac crest are considered as controls for both the iliac and sternal marrow.

Roentgen therapy consisted of a total of 2,400 r (in air) administered to each of four pelvic fields covering an area 10 by 15 cm. Treatment factors were 200 kv., 18 ma., 1.0 mm. Cu half-value layer, 50 cm. target skin distance. The treatment period covered approximately twenty-eight days, and therapy was given daily for six

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TABLE I

ANALYSIS OF CASES

Case	Age	Pathological Diagnosis	Days of Roentgen Therapy	Day of Marrow Aspiration	Day of Implantation of Radium	Remarks
1	29	Epidermoid carcinoma	1st through 37th day	12	12 26	Roentgen and radium therapy combined
2	36	Sq. cell carcinoma, grade 2	1st through 29th day	15	15	
3	47	Sq. cell carcinoma, grade 2	1st through 18th day	17	25	
4	33	Sq. cell carcinoma, grade 2	1st through 33rd day	23	23 37	Roentgen therapy interrupted by radium implantation
5	50	Intra-epith. carcinoma	1st through 17th day 22nd through 26th day 28th through 39th day	29	29	Roentgen and radium therapy combined late in period
6	41	Sq. cell carcinoma, transitional grade 2	1st through 28th day	40 90	40	Panhysterectomy 90th day
7	47	Sq. cell carcinoma, grade 2	1st through 20th day	40	40	Diarrhea after 40th day; panhysterectomy 104th day
8	60	Intra-epith. carcinoma	1st through 18th day	43	43	
9	65	Sq. cell carcinoma, grade 2	1st through 28th day	67	67	
10	63	Sq. cell carcinoma	1st through 28th day	74	74	Sternal marrow sample only on 74th day
11	47	Uncertain	1st through 27th day		None	Repeat biopsy showed no evidence of carcinoma. Therapy discontinued. Case included for peripheral blood study only
12	45	Cervical polyp. Intra-epith. carcinoma	1st through 18th day 20th through 25th day		19	No marrow samples after treatment. Case included for peripheral blood study only

TABLE II

QUANTITATIVE VALUES OF MARROW ASPIRATED FROM THE ILIAC CREST AND THE STERNUM BEFORE AND AFTER INITIATION OF RADIATION THERAPY

Case	Before Therapy Iliac Crest				Day of Therapy when Marrow Obtained	After Therapy							
						Iliac Crest (percentages)				Sternum (percentages)			
	Fat	M.E.* (percentages)	RBC	Plasma		Fat	M.E.*	RBC	Plasma	Fat	M.E.*	RBC	Plasma
1	1.0	7.0	42.5	49.5	12	1.5	3.5	37.5	57.5	0.5	18.5	32.5	48.5
2	3.2	17.5	44.3	35.0	15	0.5	0.9	47.0	51.6	2.0	9.0	37.5	51.5
4	3.0	17.0	35.0	45.0	23	3.5	1.8	33.3	61.4	2.8	19.6	33.7	43.9
5	1.0	4.0	51.0	44.0	29	2.1	2.1	49.0	46.8	1.5	37.0	28.0	33.5
6	1.0	6.5	44.0	48.5	40	2.5	1.3	42.5	53.7	1.0	3.5	53.0	42.5
					90	4.0	5.0	56.0	35.0	2.0	12.0	36.0	50.0
7	1.2	6.8	50.5	41.5	104	1.0	3.9	55.5	39.6	2.0	13.0	47.0	38.0
8	1.0	5.0	53.0	41.0	43	1.9	1.5	44.2	52.4	2.0	7.8	40.1	50.1
9	2.0	2.0	42.3	53.0	67	4.0	2.0	42.0	52.0	7.7	17.3	30.8	44.2
10	1.0	1.5	42.1	54.4	74	2.0	9.0	45.0	44.0	5.9	23.8	35.6	34.7

* Myeloid-erythroid portion.

TABLE III

PARTITION OF BONE MARROW CELLS BEFORE AND AFTER RADIATION THERAPY

Case	Day of Therapy	Iliac Crest (per cent)					Sternum (per cent)				
		Precursors*	Myeloid†	Mononuclear‡	Erythroid§	Total Cells Counted	Precursors*	Myeloid†	Mononuclear‡	Erythroid§	Total Cells Counted
1	1	2.7	79.6	9.0	8.7	412					
	12	0.8	58.5	37.0	3.7	682	2.9	67.7	3.3	26.1	951
2	1	2.3	81.1	9.2	7.4	381					
	15	4.6	50.0	45.0	1.4	478	1.6	65.0	8.8	24.6	488
3	2	2.4	75.2	14.9	7.5	455					
	17						2.4	72.0	17.0	8.6	370
4	1	1.0	69.0	11.8	18.2	404					
	23	0	46.4	48.0	5.6	252	3.9	57.0	9.1	30.0	714
5	1	1.4	47.3	30.6	20.7	429					
	29	1.8	64.1	26.6	7.5	282	2.9	51.4	16.4	29.3	694
6	0	3.3	79.1	9.4	8.2	393					
	40	1.2	64.9	22.1	11.8	484	1.5	61.0	13.4	24.1	529
	90		83.6	15.5	0.9	348	3.9	55.6	14.1	24.4	411
7	1	1.6	76.0	15.6	6.8	429					
	40						2.9	61.3	12.2	23.6	451
	104	2.5	77.5	23.2	6.8	440	2.8	46.5	19.5	31.2	566
8	1	1.0	49.5	28.6	20.9	398					
	43	0.3	58.5	25.1	16.3	358	2.0	53.4	12.2	32.4	545
9	4	3.0	62.2	24.2	10.6	523					
	67	1.1	64.5	11.9	20.7	459	1.9	59.3	8.5	30.3	540
10	0	2.8	43.3	33.6	20.3	646					
	74	0.2	58.8	19.5	21.5	444	3.2	50.0	13.0	34.8	254
11	1	0.6	73.5	14.9	12.0	481					
12	2	2.8	69.0	14.6	13.6	412					

* Reticulum cells and myeloblasts.
† Leukoblasts, promyelocytes, myelocytes, metamyelocytes, band forms and adult neutrophils.
‡ Lymphocytes, monocytes, macrophages, and plasma cells.
§ Pronormoblasts, basophilic, polychromatophilic and orthochromatic normoblasts.

consecutive days a week. In some cases therapy was discontinued for a few days because of toxic symptoms (abdominal pain or diarrhea) or excessive vaginal bleeding.

Radium in doses of 3,500 to 5,000 milligram hours was implanted by means of Ernst applicators (Table I). For this procedure the patient was taken to the operating room and a general anesthetic (sodium pentothal) was used.

RESULTS

Bone Marrow. Quantitative values of the marrow aspirations are shown in Table II. The partition of the differential of the bone marrow aspirations taken from these patients is shown in Table III in chronologic order. As can be seen, the initial aspirations from the iliac crest were fairly consistent, indicating that samples obtained from this site were representative.

A relative decrease in the erythrogenic cells and an increase in the mononuclear cells was noted as early as twelve days after the beginning of radiation therapy. The proportion of lymphocytes in the "mononuclear fraction" actually grew larger during the first nineteen days of radiation therapy. In later samples the number of lymphocytes regressed and the "mononuclear fraction" was composed predominantly of monocytes, macrophages, and

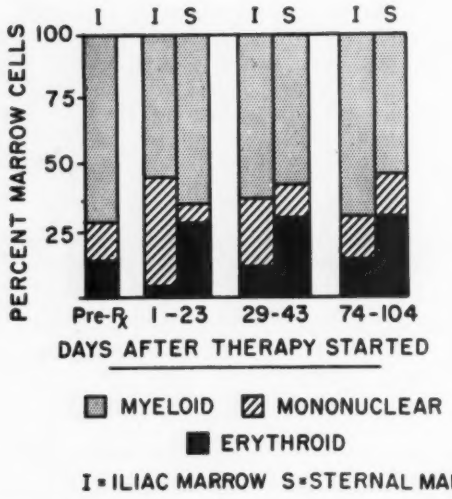

FIG. 1. Proportions of cell types in the iliac and sternal marrow in 8 patients during and after roentgen therapy for carcinoma of the cervix. Proportions are averages of 8 cases in the pretreatment period, 3 cases in the period 1–23 days, 3 cases in the period 29–43 days and 2 cases in the period 74–104 days.

plasma cells. Still later in the course of therapy the proportion of monocytes in the marrow near the site of irradiation increased as much as five times.

After the roentgen therapy was discontinued, the proportion of erythrogenic cells increased, sometimes reaching levels above those found before irradiation was started. In only 1 case (Case 6) were the erythrogenic cells depressed ninety days after therapy was begun. Some fluctuations occurred in the proportion of myeloid cells but these changes were not as extensive.

Figure 1 shows the contrast in proportions of marrow cells of 8 patients during the period of treatment (3 cases), the period immediately following cessation of therapy (3 cases), and the period six weeks after therapy had been discontinued (2 cases). The relative differences in the proportions of the three marrow elements in the marrow from the iliac crest contrast strongly with the proportions of these elements in the marrow obtained from the sternum. During the period immediately after therapy was discontinued there is a slight increase in erythroid cells and decrease in mononuclear cells in the marrow obtained from the iliac crest. In the period six weeks after cessation of therapy both the erythroid and the mononuclear fractions more nearly approach the proportions seen in the marrow prior to therapy.

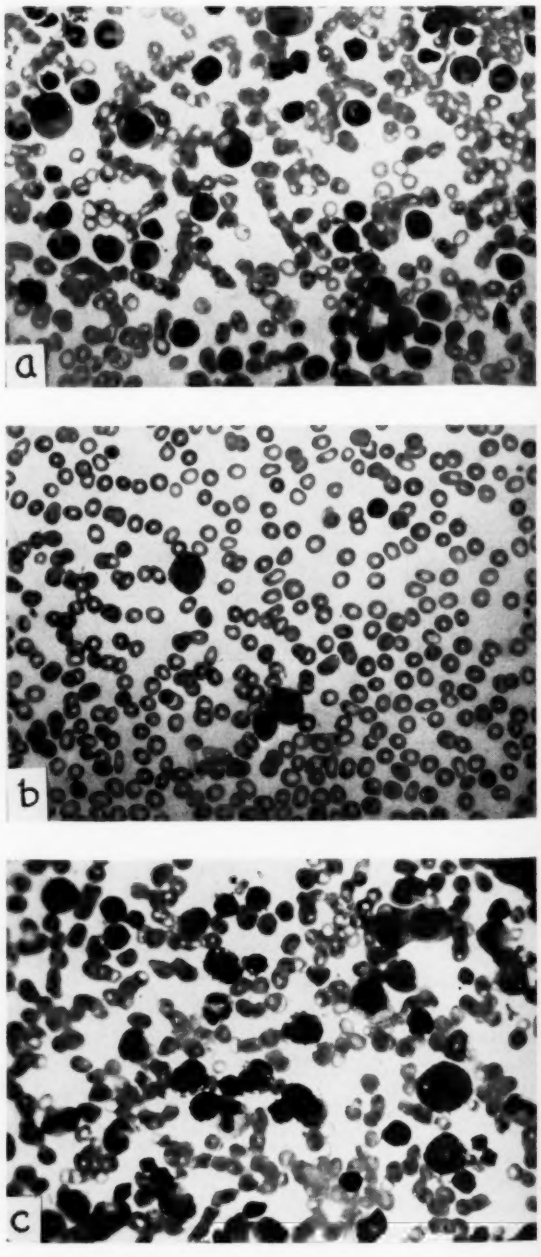

FIG. 2. Microscopic patterns of smears from first drop aspirated in Case 4. (*a*) Iliac crest before therapy, (*b*) iliac crest and (*c*) sternal marrow on 23rd day after therapy was initiated. ×330.

In contrast to the changes occurring in the bone marrow adjacent to the site of irradiation, the sternal marrow aspirated at the same time was characterized by hypercellularity of all elements, with a pronounced rise in the proportion of erythrogenic cells and a decrease in the proportion of mononuclear cells (Fig. 1). No tumor cells were seen in any marrow sample.

Figure 2 shows the microscopic appearance of samples of bone marrow obtained from the sternum and from the iliac crests in 1 patient. The contrast between the samples of iliac and sternal marrow taken on the same day in the treatment period is most striking when the size of the marrow particles is compared. The material aspirated from the iliac crest contained a few fine particles and resembled peripheral blood in appearance, while that from the sternal marrow was thick and contained large particles up to 2 mm. in diameter.

Peripheral Blood. In every case a fall in the white blood cell count below 5,000 cells per cubic millimeter occurred at some time during the period of treatment. A decrease in the absolute values for lymphocytes was noted within the first eight days, accompanied by a decline in the number of adult neutrophils. Later in the course of therapy the absolute values for eosinophils tended to rise. Metamyelocytes were noted in small numbers in the peripheral blood of 11 of the patients, though the stage at which they appeared and disappeared was extremely variable.

The decrease in absolute values for lymphocytes in the peripheral blood was prolonged. One case was followed sporadically for three and a half months, and 4 other cases were followed for six to eight months after completion of therapy, and in none of these did relative or absolute lymphocytosis occur.

DISCUSSION

Denstad,[3] following a detailed study of the marrow during and after radiation therapy of patients suffering from a variety of malignant diseases, demonstrated changes of a hypoplastic-aplastic nature at the site of irradiation, but noted no definitive alterations of the bone marrow in areas distant from the irradiated sites. He emphasized the fact that the erythrogenic cells seemed to be highly sensitive to irradiation as judged by a decrease in the incidence of mitotic figures. It is of particular interest to note that at certain intervals the proportion of lymphocytes in the irradiated marrow increased, a finding duplicated in our series.

Our studies indicate that the proportion of lymphocytes in the irradiated marrow is highest at the time when the absolute values for these cells in the peripheral blood show a marked decline. Denstad attributed this finding to the fact that specimens removed by aspiration are more often diluted with peripheral blood when the marrow is depleted, but there are other explanations which might be entertained. One alternative hypothesis is that the damaged marrow traps lymphocytes from the circulation. Such a possibility cannot be denied, as mechanisms of this nature have been observed in connection with the spleen[12] and the lungs.[6] Secondly, it might be postulated that the lymphatic tissue, except for the small amount found in the bone marrow,[16,19,24] is not affected by the inhibition of mitosis[25] caused by irradiation used under the conditions of this study. Thus, production of lymphocytes continues outside the irradiated area and the pathologic pattern of repair is represented by the occurrence of large numbers of lymphocytes from the peripheral blood in the damaged bone marrow. A third possibility is that the mechanism of the "alarm reaction" produced by irradiation may be to favor redistribution rather than lysis of the circulating lymphocytes.[23] The co-existence of peripheral lymphopenia and marrow lymphocytosis might thus be explained by one or more of these mechanisms.

The amount of radiation reaching the sternal marrow by "backscatter" from local irradiation to the pelvis is considered neg-

ligible. It is obvious, however, from the following that the sternal marrow was irradiated to some extent in these patients by the use of radium. Radiologists use the following formula for calculating the spread of irradiation when radium is used: $\frac{8.4 \text{ r/mg. hr.} \times \text{mg. hr.}}{\text{distance}^2}$. Assuming the distance from symphysis pubis to the level of the sternal attachment of the second rib to be 25–35 cm., and dosage by local implantation of radium to be 3,500 mg. hr., the amount of radiation reaching the site of sternal aspiration may be calculated as between 14 and 26 r. It has been shown that the hematopoietic effects of a small dose of radiation are apparent within minutes or hours,[10,13,14] and with the exception of 2 patients in this study, marrow was aspirated from the sternum less than one hour after radium was implanted. The stimulating effects of small amounts of radiation on the cells of the marrow has now been generally discounted.[2,7] Any observable effect, therefore, should be one of depression of cellular function. If such were present in this series it could not be discerned in the presence of the increased cellularity observed in marrow aspirated from the sternum. It would appear, then, that the contrast between the samples of marrow from the sternum and the iliac crest after irradiation in our cases is the result of compensatory and regenerative changes in the sternal marrow[23] in response to roentgen therapy directed at the pelvic region.

The ability of the bone marrow to recover from the effects of this amount of radiation is apparently excellent. Even in the cases in whom irradiation extended beyond the twenty-eight days usually required for this type of therapy, the erythrogenic cells in the marrow of the iliac crest showed a tendency to increase after cessation of treatment. At the same time the myeloid cells, while not greatly altered in proportion to the other marrow constituents, continued to show an increase in the number of mature forms (Fig. 1). The compensatory effort on the part of sections of the marrow organ distant from the site of irradiation must be considered as a potent factor in effecting the return of the peripheral blood to normal values.

Peripheral Blood. In human subjects treated by roentgen therapy for various malignant conditions, Minot and Spurling[11] noted the following factors to be related to the greatest decrease of the white blood cells of the peripheral blood: (a) heavy doses of irradiation; (b) exposure of large surface area to roentgen rays; (c) the existence of leukopenia prior to treatment, and (d) the use of a second course of irradiation before "complete recovery" takes place. They noted that recovery of the blood took place within four to six weeks. Kornblum and his associates[5] concluded that the anatomical region irradiated as well as the amount of radiation given was of importance in determining the effect on the white blood cells of the circulating blood. Although the possibility of transference of the effects of irradiation by means of the circulating blood was denied by Lawrence and his colleagues,[8] they state that at times in irradiated animals leukopenia seemed to occur which was out of all proportion to the dose of roentgen therapy.

In the 12 patients in this study the amount of radiation and the area of exposure were relatively constant. The duration of therapy was longer than in any of the three groups reported by Minot and Spurling. Intervals between treatments with roentgen rays, radium, or both were never greater than three or four days. The effects upon the peripheral blood count seemed to be essentially the same whether roentgen therapy was used alone or combined with radium therapy.

The rise in eosinophils observed during the third and fourth weeks after the institution of therapy has been noted by previous workers,[11,22] but has not been satisfactorily explained. While there are other factors to be considered in evaluating this phenomenon, for example allergy and parasitism, the eosinophilia must be attributed in part to the therapy itself. Selye's[21] pres-

entation of the general adaptation syndrome and the various responses of the body to stress has introduced entirely new concepts as possible explanations for the response of the blood to radiation therapy.[20] Hormonal factors may be responsible for the so-called "distant" effects of localized roentgen therapy. In our cases the disturbances of endocrine balance caused by direct irradiation of the ovaries might well have affected the blood picture.

SUMMARY AND CONCLUSIONS

Twelve patients treated by radium and roentgen radiation for carcinoma of the cervix uteri were studied by means of marrow aspirations from the sternal and iliac crest as well as by serial counts of the peripheral blood. Absolute leukopenia, neutropenia, and lymphopenia occurred in the peripheral blood and persisted for variable periods of time. Neither absolute nor relative lymphocytosis was observed in the peripheral blood at any time during or after the treatment period.

Examinations of material aspirated from the marrow adjacent to the site of irradiation showed marked depletion of all the marrow elements while the samples from the sternal marrow exhibited increased cellularity. Early in the course of roentgen therapy there appears to be a transient lymphocytosis in the irradiated bone marrow.

In most cases evidences of recovery were demonstrated in the bone marrow from the irradiated area from twelve to eighty-four days after roentgen therapy had been discontinued.

Possible mechanisms for these findings are discussed.

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COUNTERACTING THE ACUTE RADIATION SYNDROME WITH CORTICOTROPIN (ACTH)

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CORTICOTROPIN (ACTH)* has been effective in relieving radiation sickness, clinically, in human subjects, in the majority of cases, in at least five institutions† for several years regardless of conflicting reports on animal experimentation during this period.[14,22,27] A few of these patients have been treated with radioactive isotopes or nitrogen mustard in lieu of roentgen therapy, and some of them received "grid therapy."[11,13,29] A few cases of lymphoma effectively treated with 10 international units of ACTH have also been included in this report to further prove that these small doses are sufficient to produce results. The key to our success without ill effects is the use of small doses of ACTH in patients with functioning adrenals.

Since 1949, we have been treating radiation sickness successfully with doses of 10 I.U. of corticotropin daily or thrice weekly without decreasing or discontinuing roentgen therapy when other methods of its treatment fail. Corticotropin need not be given before commencing roentgen therapy in order to be effective as do the bioflavinoids.[24] Usually, corticotropin is started two weeks or more after the commencement of roentgen therapy. However, bioflavinoids were used in addition to ACTH in one patient in preparation for and during grid therapy, having previously received a full course of conventional therapy; while reticulose[30] was given in addition to ACTH during grid therapy to another patient who also had previously received a full course of conventional roentgen therapy.

* ACTHAR (Armour). The ACTHAR for this study was provided by the Armour Laboratories.

† Orange County Hospital, Orange, California; Emory Tumor Group, Los Angeles, California; North Orange County Clinic, Fullerton, California; Santa Ana Community Hospital, Santa Ana, California, and Golden Clinic, Memorial General Hospital, Elkins, West Virginia.

THEORY

In my preliminary report,[27] the theory was discussed upon which I based my opinion that ACTH should relieve radiation sickness. I then tried it in humans and it relieved them of the ill effects of roentgen therapy. I believe that radiation sickness is "an alarm reaction" due to the "stress action" of roentgen rays and should be included under the designation of the "general adaptation syndrome" as the "stage of exhaustion." Selye,[21] Smith,[23] and others,[7,18] now concur in this opinion. Therefore, ACTH or cortisone should be indicated. Corticotropin was selected in preference to cortisone because of producing a more even and constant blood level and because it does not result in atrophy of the adrenal cortex.[26] Furthermore, corticotropin stimulates the adrenal cortex to produce its entire spectrum of hormones of which cortisone is only one and it may not be the only one effective in relieving radiation sickness. Of course, when the adrenal cortex is insensitive, there is little benefit derived from trying to bring it back;[28] and Reiss[20] has shown that hypothyroidism results in poor response of the adrenal cortex to ACTH. Cortisone should probably not be tried with roentgen therapy because of the possibility of operating synergistically to alter the patient's resistance to a variety of infectious agents.[10]

Although no known single reaction is peculiarly specific for radiation injury, everyone knows that it is necessary to:

1. Restore or maintain fluid and mineral balance despite the damaged gastrointestinal tract.
2. Maintain protein balance.
3. Restore the hematopoietic system.
4. Supply nutrients.
5. Minimize loss of blood and body fluids.
6. Control infection by antibacterials.

It is now also well known that corticotropin accomplishes the first three of these if taken separately[8,16,17,19,31,34] except for the lymphopenia which it causes in larger doses. We have found that, in small doses, it also accomplishes all of the first three when found in combination as in radiation sickness without seriously affecting the lymphocytes; and overcomes the nausea and diarrhea so as to assist in supplying nutrients, besides. Furthermore, hypercoagulability of the blood associated with the administration of ACTH has been observed,[3] so that the control of infection by antibacterials appears to be the only factor listed above which is not accomplished by corticotropin. Weakness, anorexia and fall in blood pressure are notably overcome by corticotropin[15] as we have also found in treating these signs and symptoms of radiation sickness.

One month after my preliminary article was accepted for publication, Cosgriff and Kligerman[4] had an article accepted for the same journal, in which they reported a case of acute postirradiation pulmonary reaction successfully treated with ACTH and cortisone. Bluestein and Roemer[1] found cortisone valuable in combating radiation pneumonitis. Friedenberg and Rubenfeld[9] more recently have reported 9 patients given cortisone who did not develop pulmonary fibrosis in spite of intensive doses and observed subjective improvement. One of their patients received cortisone for a severe reaction following irradiation and showed marked symptomatic improvement.

It is my opinion that the ill effects of ACTH in fatally irradiated mice reported by others[22] are due to the larger doses of the hormone which they administered, adding insult to radiation injury of the lymphocytes, etc. The important factor in treatment of radiation sickness with ACTH is the use of small dosages of this hormone.

CASES SELECTED AND FACTORS USED

Patients who are not relieved of their radiation sickness by the bioflavinoids,[24] reticulose[30] or conventional methods of its treatment were given corticotropin. Only those patients exclusively treated with ACTH are included in this report.

Bioflavinoids, when used, were started prior to radiation treatment and all of my patients were given kapseals of ABDEC, combex with vitamin C, thiamine chloride and pyridoxine or vitamin B_{12} prior to and during radiation therapy and 50 milligrams of benadryl p.r.n. One was given the reticulose. When radiation sickness developed in spite of these measures, they were discontinued and corticotropin was administered. Most of the patients reported here received 200 r (in air) or more of hard roentgen rays daily or thrice weekly through sizable fields over the torso totalling 2,000 r or more per field (in air).

METHOD OF TREATMENT WITH CORTICOTROPIN

The first patients treated with corticotropin were given 5 I.U. intramuscularly either daily or thrice weekly. These injections were ineffective but served as placebo controls for the favorable results subsequently obtained by larger doses. This dose was doubled and all patients subsequently received 10 I.U. at each visit until the symptoms of radiation sickness disappeared. The radiation therapy was never decreased or discontinued during the administration of corticotropin. Only one patient received testosterone for nitrogen balance because of repeated series of ACTH necessary due to her poor physical condition at the beginning of the irradiation caused by the advancement of her malignant growth at that time. Corticotropin was discontinued as soon as the patients were relieved of their radiation sickness. Some of them received it intermittently, being relieved several days or weeks by one injection, or a short course of injections, respectively.

CONTRAINDICATIONS TO CORTICOTROPIN

Although we have found no complications attributable to corticotropin in these

small doses, we would not use them and would advise against their use in tuberculosis, chronic arthritis with azotemia, acute psychosis, Cushing's syndrome and active peptic ulcer. ACTH should be used with caution in the presence of infections other than tuberculosis, congestive heart failure, hypertension, mental disturbances and diabetes mellitus.

The use of corticotropin in the presence of severe burns had been discouraged until Dr. M. James Whitelaw of Phoenix, Arizona, exhibited at the Fourth Annual Clinical Session of the American Medical Association on December 5, 1950, in the Cleveland Public Auditorium, a case of thermal burns involving 70 per cent of the body surface of a twenty-three year old male who was treated exclusively with corticotropin during the period of observation. Pinch homografts were applied on the forty-third day to some of the burned areas with resulting complete epithelization. Trusler *et al.*[32] use ACTH with skin grafting after burns and advocate it in spite of the fact that they recognize that susceptibility to generalized infection occasionally occurs.

RESULTS

Del Regato[6] states that the best way to deal with radiation sickness is to avoid it entirely! This is not possible while administering grid therapy, in our experience.

Jenkinson[12] has found that ACTH relieves radiation sickness in 45 to 50 per cent of cases and reports spectacular results in some patients. His experience with ACTH in radiation sickness has been fair; but he has had to use 25 mg. in some patients. Jenkinson has also used cortisone.

Sosman[25] was one of the first to try cortisone to relieve radiation sickness and states that his preliminary trial was impressive. However, when he instituted rigid controls he found that the good results were due to psychological factors and not due to the cortisone.

Carpender[2] is using ACTH but has not yet analyzed his results. Vastine,[33] is also using ACTH and is favorably impressed but has not had sufficient experience to have reached any definite conclusions. Cox[5] has used cortisone with "considerable help." Porter[19] is using cortisone and plans to publish the results of such treatment as soon as he can gather a sufficient series.

The following named doctors have indicated in personal communications to me that they have found ACTH to relieve radiation sickness in the majority of cases so treated by them:

USING 10 I.U. OF ACTH PER TREATMENT DAY

Goodrich, W. A., West Hartford, Conn.
Romagosa, J. J., La Fayette, La.
Young, G. E., Skowhegan, Me.
Hartung, W., Davenport, Ia.
Benesh, A. J., Seattle, Wash.
Boice, R. H., Parkersburg, W. Va.
Campbell, J. A., Indianapolis, Ind.
Perisho, G., Quincy, Ill.
Ogden, R. T., Hartford, Conn.
Lewis, J. W., Colorado Springs, Colo.
Williams, F. B., San Francisco, Calif.

USING 15 TO 50 MG. PER DAY

Berger, R. A. Davenport, Ia.
Uhlmann, E. M., Chicago, Ill.
Glaess, A. W., Freeport, Ill.

Our results are shown in Chart 1 which indicates that most of the patients we have treated with corticotropin have been relieved of their radiation sickness by 10 I.U. intramuscularly, daily or thrice weekly, while roentgen therapy was continued. Some of them were relieved by three such injections while two required only a single injection of ACTH. A few required much more than this but were temporarily relieved by each injection, at least; and one of these was controlled for two weeks at a time by four or five injections of 10 I.U. each. Several patients died of their primary disease while under treatment as shown by autopsy examinations.

None of our patients developed clinical edema, rounded facies, psychic phenomena or electrolyte imbalance. The usual laboratory procedures were carried out on most of these patients and many of them had their urine examined for 17-ketosteroids,

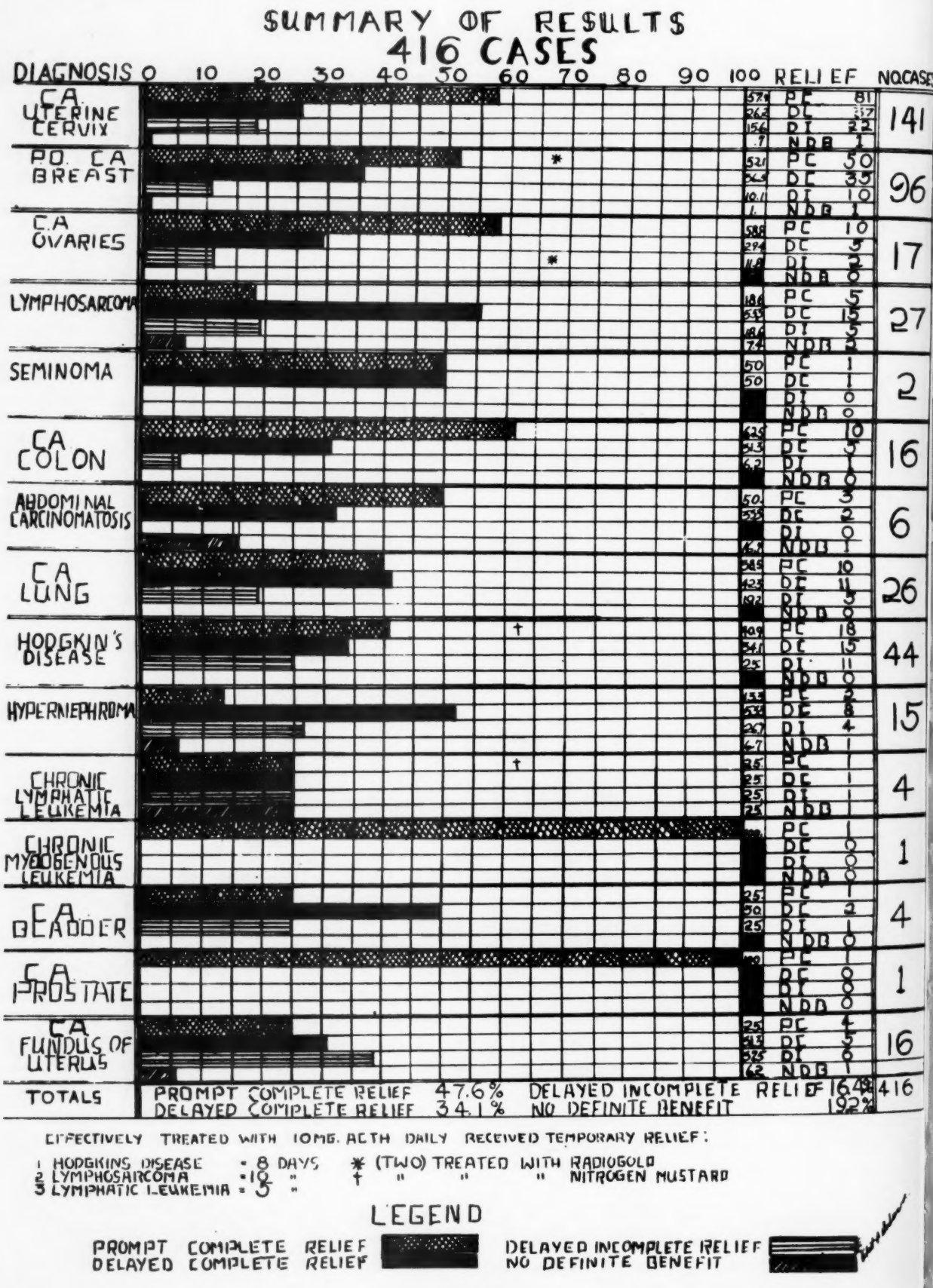
SUMMARY OF RESULTS
416 CASES
DIAGNOSIS
0 10 20 30 40 50 60 70 80 90 100
RELIEF
NO CASES
CA. UTERINE CERVIX
57% PC 81
26% DC 37
15% DI 22
1% NDB 1
141
PO. CA BREAST
52% PC 50
34% DC 35
10% DI 10
1% NDB 1
96
CA OVARIES
58% PC 10
29% DC 5
11% DI 2
NDB 0
17
LYMPHOSARCOMA
18% PC 5
55% DC 15
18% DI 5
7% NDB 2
27
SEMINOMA
50% PC 1
50% DC 1
DI 0
NDB 0
2
CA COLON
62% PC 10
31% DC 5
6% DI 1
NDB 0
16
ABDOMINAL CARCINOMATOSIS
50% PC 3
33% DC 2
DI 0
17% NDB 1
6
CA LUNG
38% PC 10
42% DC 11
19% DI 5
NDB 0
26
HODGKIN'S DISEASE
41% PC 18
34% DC 15
25% DI 11
NDB 0
44
HYPERNEPHROMA
13% PC 2
53% DC 8
27% DI 4
7% NDB 1
15
CHRONIC LYMPHATIC LEUKEMIA
25% PC 1
25% DC 1
25% DI 1
25% NDB 1
4
CHRONIC MYELOGENOUS LEUKEMIA
PC 1
DC 0
DI 0
NDB 0
1
CA BLADDER
25% PC 1
50% DC 2
25% DI 1
NDB 0
4
CA PROSTATE
PC 1
DC 0
DI 0
NDB 0
1
CA FUNDUS OF UTERUS
25% PC 4
38% DC 6
37% DI 6
6% NDB 1
16
TOTALS
PROMPT COMPLETE RELIEF 47.6%
DELAYED COMPLETE RELIEF 34.1%
DELAYED INCOMPLETE RELIEF 16.4%
NO DEFINITE BENEFIT 1.9%
416
EFFECTIVELY TREATED WITH 10MG. ACTH DAILY RECEIVED TEMPORARY RELIEF:
1 HODGKINS DISEASE = 8 DAYS
2 LYMPHOSARCOMA = 10 "
3 LYMPHATIC LEUKEMIA = 5 "
* (TWO) TREATED WITH RADIOGOLD
† " " " NITROGEN MUSTARD
LEGEND
PROMPT COMPLETE RELIEF
DELAYED COMPLETE RELIEF
DELAYED INCOMPLETE RELIEF
NO DEFINITE BENEFIT

CHART I

11-oxysteroids, creatinin, uric acid and glucose in the twenty-four hour specimen without showing alterations attributable to corticotropin. The fact that no appreciable changes were found in the excretion studies was believed to be due to the small doses of corticotropin administered. Therefore, the special excretion studies were discontinued in the majority of cases reported herein.

CONCLUSION

The treatment of postirradiation injury with corticotropin in small doses is of value. Corticotropin in small doses should be included in the armamentarium of drugs used whenever radiation hazard exists, whether in the treatment of malignant conditions by roentgen radiation, in the use of radioactive isotopes or in fission bomb disasters. It has made it possible for us to administer radiation therapy more intensively and in much higher doses through a grid without unwarranted discomfort to the patient.

Golden Clinic, Memorial
General Hospital
Elkins, West Virginia

The Santa Ana Community Hospital initially made this study possible and has assisted in financing it. The Armour Laboratories provided the Corticotropin used in this study. Dr. Clyde K. Emery of Los Angeles, Dr. Mildred Wehrly of the Orange County Hospital and Dr. Kenneth V. Powers of North Orange County Clinic have provided me with the summaries of case histories on the patients whom they have treated with ACTH in a similar routine to mine. Their cases are included in the accompanying chart which was largely prepared by Dr. Jack C. Gilbert who assisted me during part of this study.

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A PHOTOGRAPHIC METHOD FOR MEASURING THE DISTRIBUTION OF DOSAGE FROM RADIUM NEEDLES AND PLAQUES

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THE distribution of radiation dosage surrounding a linear source of radium or a prescribed combination of sources can be derived mathematically. Various investigators have prepared dosage tables and charts aimed at simplifying such mathematical calculations. Paterson and Parker have constructed a dosage system for gamma-ray therapy which provides a uniform distribution of dosage over a given area or volume whenever a specified geometrical distribution of radium is observed.[5,6] By utilizing such schemes many of the routine problems of radium therapy can be efficiently handled without recourse to mathematical analysis.

On the other hand, many problems are encountered which require an accurate physical method of determining the distribution of radiation dosage from radioactive sources. Although mathematical calculations are completely adequate for any simple geometric arrangement of sources, they become exceedingly laborious whenever a special distribution is required.

With the construction of the automatic isodose recorder using a scintillation crystal as the gamma-ray detector, Hine and Friedman[3] were able to measure, physically, the radiation fields produced by various radium sources. Isodose curves obtained in this manner, were in good agreement with those constructed mathematically. However, the distribution of dosage around the ends of various needles showed an asymmetrical pattern rather than the generally assumed symmetrical pattern. Such fields cannot readily be determined mathematically because of the complex filtration problem involved.

This report describes a photographic method of measuring radiation fields surrounding any combination of radium sources. Such a technique offers one direct advantage in that it can readily be adapted to the dosimetry program of any radiotherapy department. The outlay for necessary equipment is small, only a densitometer and standard darkroom facilities being required.

EXPERIMENTAL APPARATUS

All film exposures were made using Eastman Type M industrial x-ray film. The films were developed for five minutes at 68° F. with Eastman Liquid Developer. Densities were measured with an Ansco color densitometer, Model 12. This densitometer, which utilizes a photomultiplier tube as a detector, measures densities to 6.0. The instrument was modified by substitution of an aperture of 0.01 cm. diameter for the one supplied with the instrument. Since the new aperture allows the measurement of density over a small (10^{-4} cm.^{2}) area, dose can be measured accurately even in regions close to the source, where the intensity falls off rapidly with distance. The maximum density that can be read using the new aperture is 3.0.

Greening[2] has shown that an absorber thickness of 200 mg/cm.^{2} is required to produce electron equilibrium when film is exposed to radium. Consequently, all exposures were made with the films enclosed in a Graflex 4 by 5 inch film holder and sandwiched between two sheets of aluminum 210 mg/cm.^{2} thick.

Three 4 by 6 cm. radium plaques were constructed and loaded with needles having an activity of 2.4 mg. radium and an active length of 2.0 cm. They were identical to the plaques for which Quimby[7] calculated dosage charts at various distances from the surface.

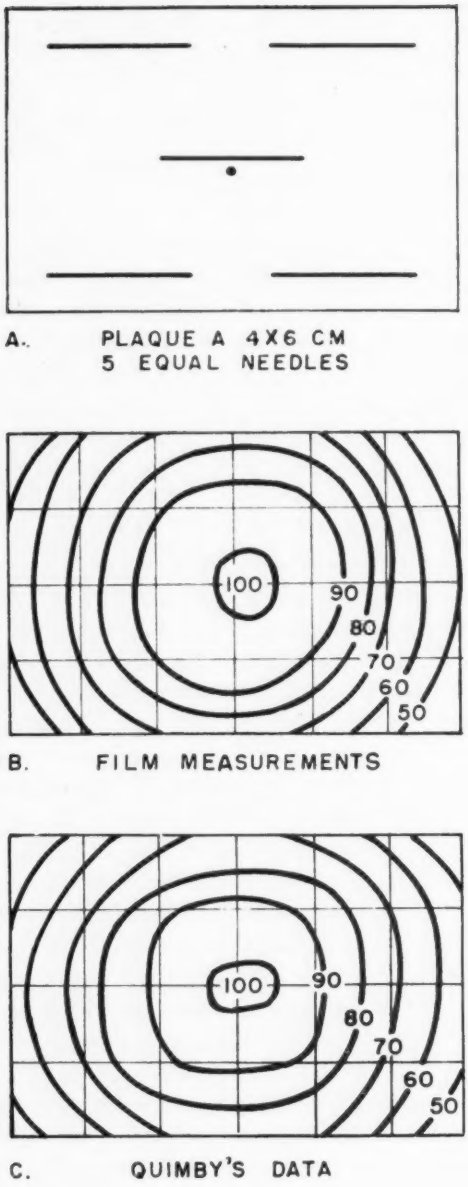


FIG. 1. Comparison of photographic and theoretical dose distribution for Plaque A.

EXPERIMENTAL RESULTS

Figure 1 shows the distribution of dosage in air, 2 cm. from the surface of a plaque containing 5 radium needles (Plaque A). Results of the photographic measurements are compared with Quimby's mathematical data. Figures 2*B* and 2*C* show the distribution of dosage measured at distances of 1 cm. and 2 cm. from a plaque containing 10 needles (Plaque B). Figures 2*D* and 2*E* show the distribution from the same plaque as calculated by Quimby. Figures 3*B*, 3*C*, 3*D*, and 3*E* show a similar series of comparison for another distribution of 10 needles (Plaque C).

DISCUSSION

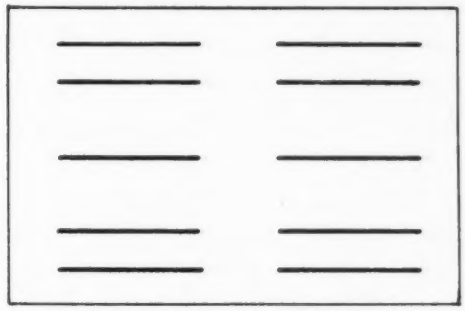
Although there is good agreement between the film and mathematical measurements shown in Figures 1, 2, and 3, the photographic method of measuring the distribution of radiation dosage has certain limitations owing to:

1. The energy dependence of film.
2. The angular dependence of film.
3. The error introduced into the density measurements by the use of a small densitometer aperture.

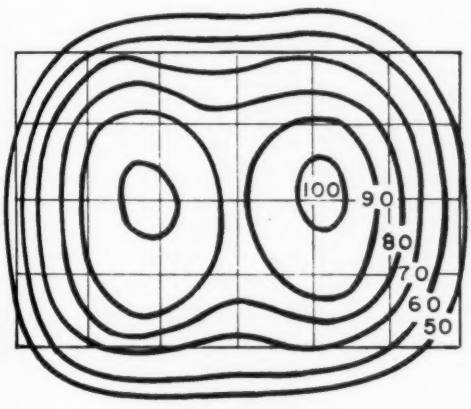
These are discussed below.

Energy Dependence of Film. The response of Eastman Type K and DuPont 552 film to roentgen rays has been investigated by Storm[8] over a range of energies extending from 0.005 to 10.0 mev., and found to be independent of energy from 0.4 to 2.0 mev. The energy response of most roentgen-ray emulsions, including that of Eastman Type M film, is essentially that of the two films described.

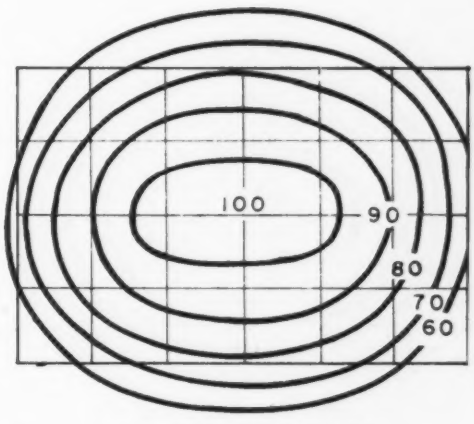
The effective energy of the complex gamma-ray spectrum from radium, filtered by 0.5 mm. Pt, is approximately 0.80 mev. Under any condition of scattering that degrades the spectrum to an effective energy below 0.40 mev., the sensitivity of film will be increased. In a study of the distribution of dosage around a radium needle in air, scattering is negligible and the energy dependence of film is of no consequence. If, however, measurements are made with the radium and film surrounded by tissue-equivalent material, scattering becomes important. At some distance from the source the energy will be degraded to a value for which the film sensitivity is increased. Whipple *et al.*[9] have compared film and ionization chamber measurements



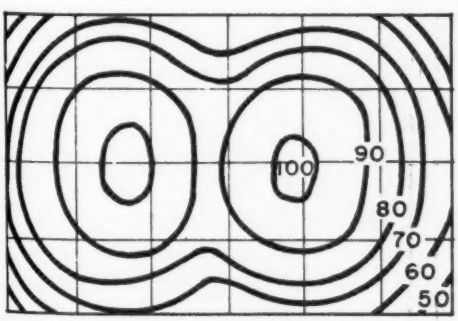
A. PLAQUE B 4X6 CM
10 EQUAL NEEDLES



B. FILM MEASUREMENTS

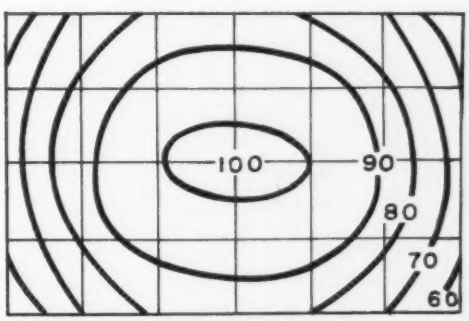


C. FILM MEASUREMENTS



D. QUIMBY'S DATA

APPLICATORS 1 CM FROM SKIN



E. QUIMBY'S DATA

APPLICATORS 2 CM FROM SKIN

Fig. 2. Comparison of photographic and theoretical dose distribution for Plaque B.

taken in phantom material. Complete agreement between the two measurements was obtained to a distance of 10 cm. At 20 cm. an increase of film sensitivity was observed. However, in most cases measurements of radiation contours surrounding radium sources are restricted to distances less than 10 cm.

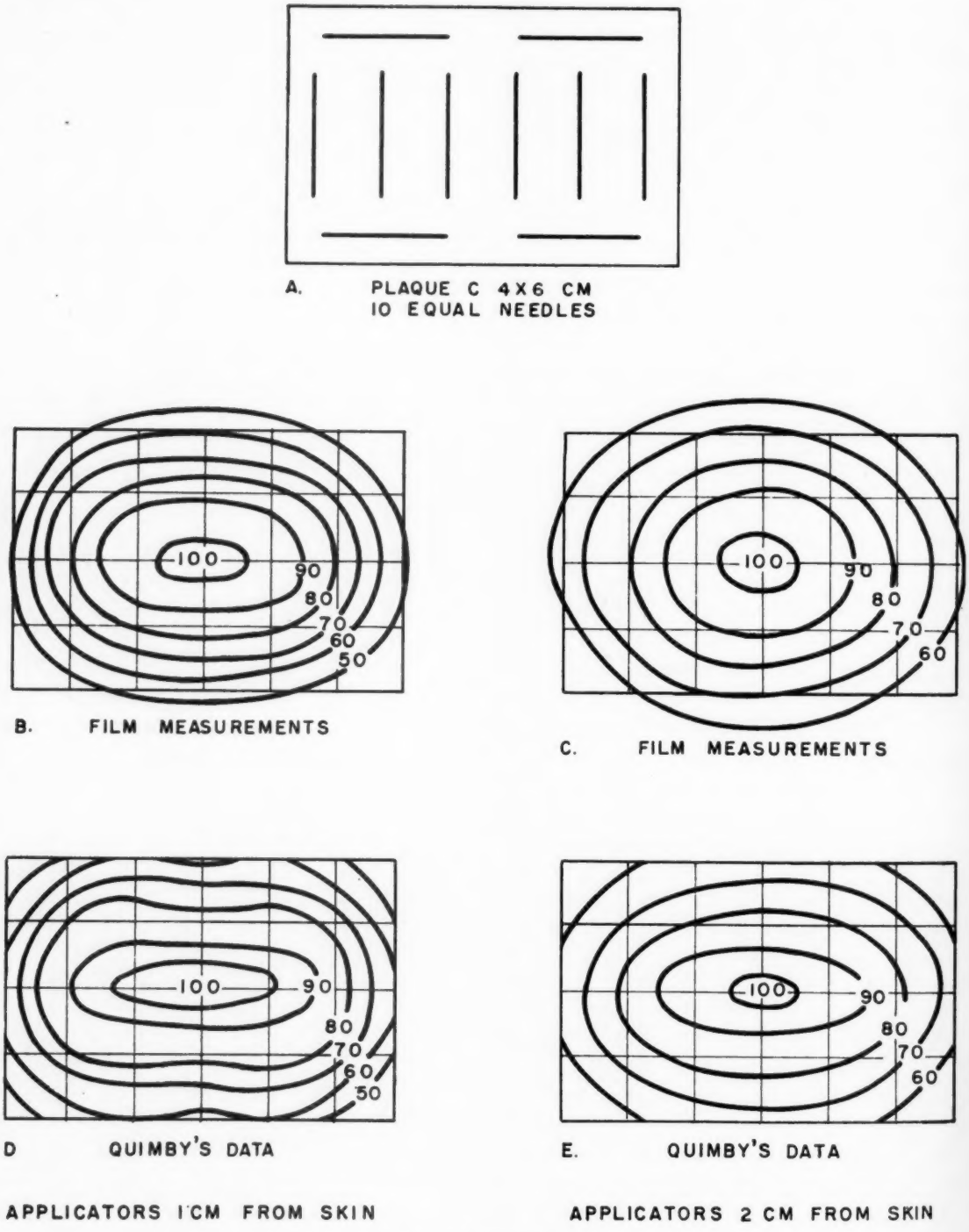


FIG. 3. Comparison of photographic and theoretical dose distribution for Plaque C.

Angular Dependence of Photographic Film. Photographic blackening of film by roentgen rays or gamma rays varies with the angle of the incident radiation. Film sensitivity is maximum when the rays are incident normal to the plane of the film (0° angular incidence) and decreases to a minimum as the rays become parallel to the

plane of the film (90° angular incidence). Greening[2] has shown that the variation of blackening for any angle of incidence relative to 0° angular incidence is dependent upon the energy of the radiation and on the emulsion thickness. Variation of blackening with angle of incidence is greatest at intermediate energies where the general direction of the secondary electrons is that of the roentgen or gamma rays producing them, and where the range of the electrons produced approaches that of the emulsion thickness. For energies above and below this optimum value there is a small decrease in angular sensitivity.

The angular sensitivity of Type M film was investigated, using gamma rays from Co^{60}. The film was sandwiched between two cylinders of cardboard and exposed to a point source of radiation. Figure 4 shows the sensitivity of Type M film at angles of incidence up to 90° relative to the sensitivity at 0° incidence. The ratio of minimum to maximum sensitivity is 0.75.

A measurement of maximum and minimum angular sensitivity of Type M film to radium was made by exposing two films simultaneously, one film resting directly beneath a radium needle, the other positioned 4.5 cm. above. Density readings on both films at a source-to-film distance of 4.5 cm. gave relative sensitivities of the film to radiation incident at angles of 90° (lower film) and 0° (upper film). The ratio of minimum to maximum sensitivity was found to be 0.77.

Thus, when making radium exposures using Type M film, maximum errors approaching 30 per cent are possible if corrections for angular sensitivity are ignored. However, with careful planning of exposure conditions such errors can be kept low.

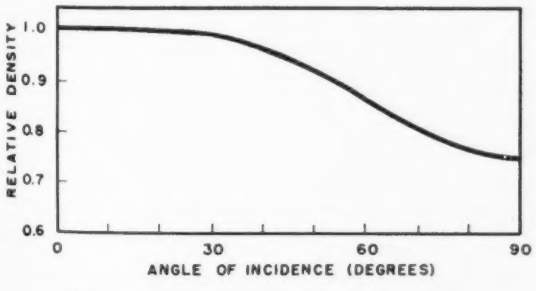


Fig. 4. Angular sensitivity of Eastman Type M industrial x-ray film.

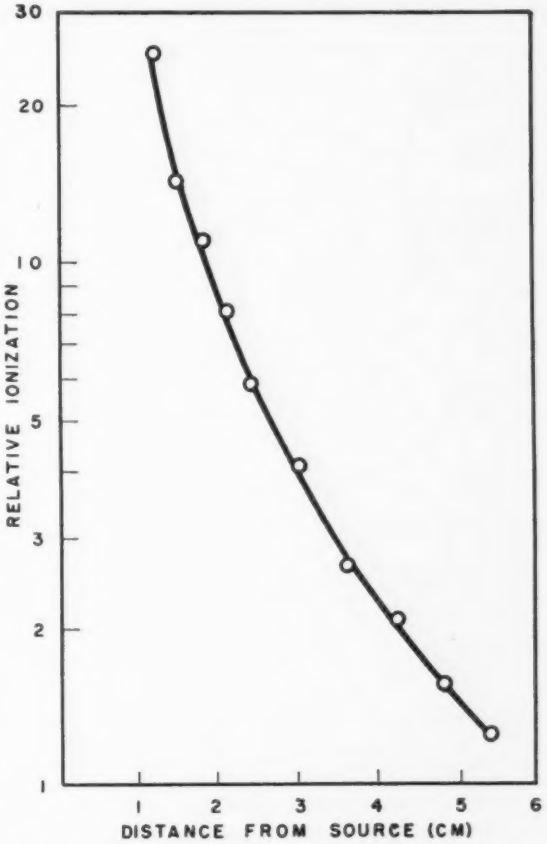


Fig. 5. Photographically measured ionization as a function of distance from source at 90° incidence (circles). The calculated ionization (solid curve) is shown for comparison.

It is possible to make accurate measurements of the distribution of dosage when the angle of incidence approaches 90°. The curve in Figure 5 was obtained from Quimby's theoretical calculation.[7] Experimental points were obtained by positioning a radium needle of 1.2 cm. active length directly on the film. Density measurements were made at distances between 1.2 and 5.4 cm. from the central axis of the needle. As can be seen from Figure 5, the experimental points agree with the calculated curve.

Density Measurements with Small Aperture. In order to attain accuracy when measuring the rapid decrease of dosage sur-

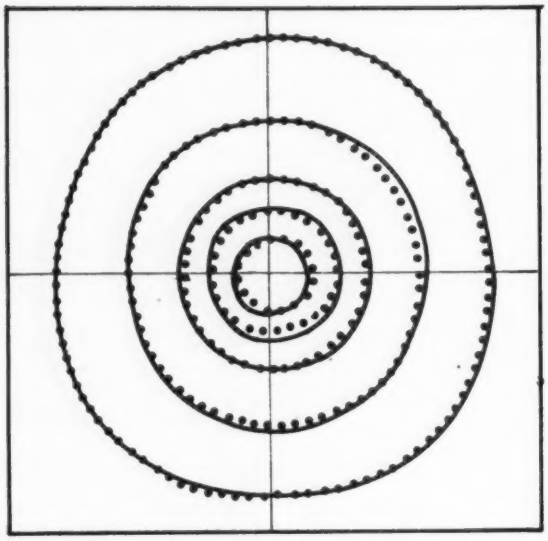


FIG. 6. Reproducibility of photographic measurements. The solid and dotted isodose curves were obtained from two films exposed under identical conditions.

rounding a source of radium, the area of film being densitometered must be kept to a minimum. There is, however, a lower limit to the size of aperture that can be used. The limiting factors are the amount of light that can reach the detector and accuracy required in the results.

The problem associated with film blackening is statistical in nature. The characteristic curve for photographic film (density plotted against the log of exposure) is sigmoid in shape, resembling the statistical curves obtained in mortality studies of biological systems exposed to ionizing radiation. Film density is proportional to the number of silver grains developed per unit area of film. Maximum density occurs when all the grains present in the emulsion are developed. If, for example, the maximum density of a film is 10, then a density of 1 indicates that 10 per cent of the grains present in the emulsion have been developed.

The variability of a single density measurement is dependent upon the number of silver grains developed within the area of the aperture used for making the measurement. For a given aperture size this variability or standard deviation (σ) is given by: $\sigma = \sqrt{N}$, where N is the number of grains counted. The relative variation in per cent can be expressed as:

$$\frac{100\sigma}{N} \text{ or } \frac{100}{\sqrt{N}}$$

TABLE I

STANDARD DEVIATION OF SMALL AREA EXPOSURE

(From Dudley[1])

Net Density	Measured Relative Variation (per cent)	Av. No. Electrons/ cm.$^2 \times 10^{-6}$	Theoretical Relative Variation (per cent of mean)[a]
0.40	3.6	3.0	3.8
0.80	2.1	6.0	2.7
1.56	1.5	12.0	1.9
2.93	1.1	24.0	1.3

[a] $\%\sigma = 100/\sqrt{N}$ where N = average number of developed grains in area of 2.3×10^{-4} cm^2.

Dudley[1] has measured the per cent relative variation of a single density measurement obtained with an aperture of 2.3×10^{-4} cm.^{2} Using Eastman No Screen x-ray film, a large number of measurements were made over an area uniformly blackened by a predetermined exposure of electrons. The individual measurements produced a gaussian distribution, for which the standard deviation was determined. Experimental measurements were compared with theoretical calculations based on the number of hits per unit area of film received by a specified electron exposure. Dudley's data are listed in Table 1.

The reproducibility of measurements using the aperture and techniques of this study can best be illustrated by reference to Figure 6, which shows isodose curves obtained from two films exposed under identical conditions, 1.3 cm. above a radium source having an active length of 1.2 cm.

A further experiment was performed to determine differences in the radiation field encountered when exposures made in air

are compared with exposures made within a phantom of tissue-equivalent material. The phantom was made of slabs of tissue-equivalent wax.[4] The phantom material completely surrounded the film and radium plaque with a minimum thickness of 7 cm. of material. The distribution of dosage was measured in air and within the phantom material using Plaque B (Fig. 2) as the radiation source. Measurements were made in a plane 2 cm. above, and parallel to, Plaque B. No significant differences were observed between the two radiation fields obtained. The ionization in air was 3 per cent greater than the ionization measured within the phantom material.

CONCLUSIONS

Agreement between the film measurements of radiation dosage from radium sources and the corresponding mathematical data is sufficiently good to justify use of the film technique. However, the limiting factors of photographic dosimetry should be carefully considered. For readings taken in air, the angular dependence of film would be the significant factor in limiting the experimental accuracy of the measured results. For measurements made in tissue-equivalent material, all readings should be restricted to distances less than 10 cm. from the source. Beyond this distance the gamma radiation is sufficiently degraded that an increased sensitivity of film is observed.*

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* The mention of trade names and commercial products in this paper is not to be construed as constituting endorsement of the products by either the author or the United States Navy. Equivalent materials and equipment of different commercial origin might serve as well, but were not chosen in this investigation.

STRAY RADIATION MEASUREMENTS AROUND A COBALT 60 BEAM THERAPY INSTALLATION

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THIS paper describes the design of a room adapted for a cobalt 60 beam therapy unit, the results of a stray radiation survey around this installation, and the changes made as a result of the survey.

DESCRIPTION OF COBALT 60 UNIT AND RADIATION

The cobalt 60 unit as shown in Figure 1 is that produced by the Atomic Energy of Canada, Limited. The cobalt head has 2 degrees of freedom. It can be moved up and down and rotated about a horizontal axis from 5 degrees beyond the vertical to 10 degrees above the horizontal. The largest field is slightly greater than 20 by 20 sq. cm. at 80 cm. from the source. This limits the region which must be protected from direct radiation to a strip along the floor and wall toward which the beam is directed.

The source is a cylinder of cobalt 60, 2.5 cm. in diameter and 1 cm. thick, contained in a small steel "pill box." This in turn is housed in lead within a stainless steel shell. (See cross section diagram of Fig. 2.) In front of the source is a conical container filled with mercury, which absorbs the radiation when the machine is not used, but which is pumped out by remote control when the radiation is used. If the power should fail or someone should open the door to the therapy room, the mercury would run back into the container by gravity,

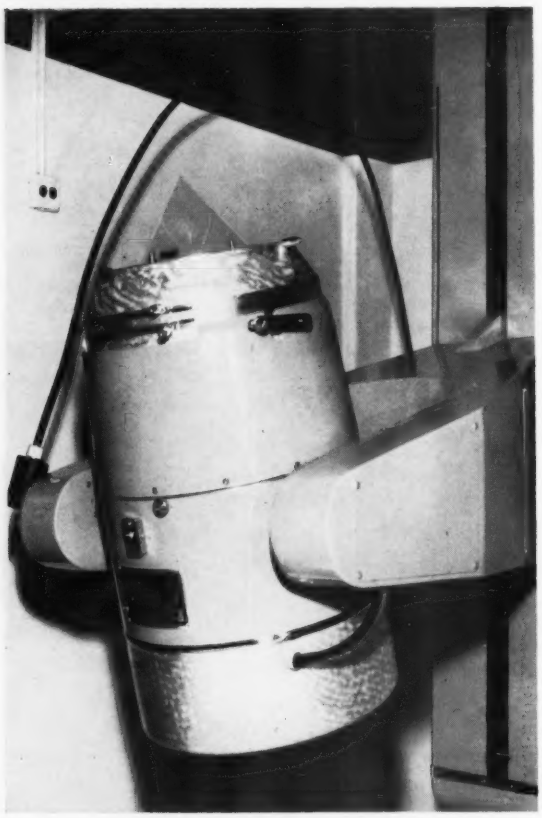

FIG. 1. Cobalt unit.

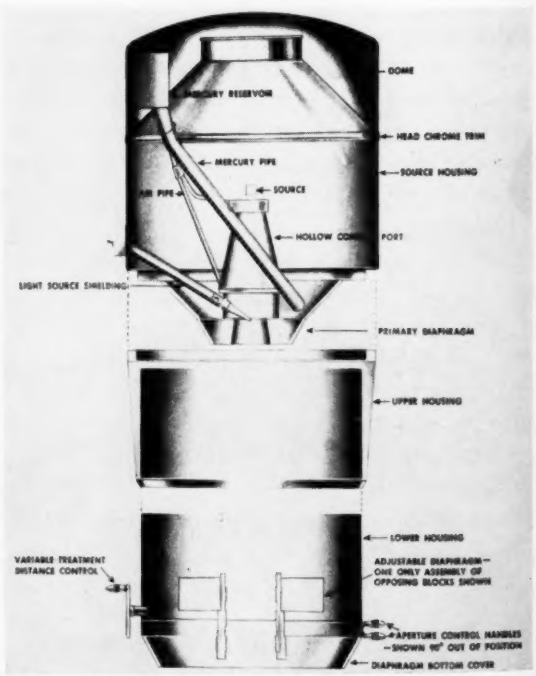

FIG. 2. Cross section of unit.

allowing the machine always to be safe.

In its decay to nickel 60, cobalt gives off a low energy beta ray of 0.3 mev. and two lines of gamma radiation: a 1.17 mev. line and a 1.33 mev. line. The beta rays are either self-absorbed by the source or in the steel pill box.

The gamma radiation is equivalent in penetration to the roentgen rays from a 2 mev. roentgen-ray machine. The output of our unit was 32 r/min. at 80 cm. s.s.d. (source skin distance) at which we use it.

DESIGN OF ROOM PROTECTION

The machine was placed on one side of a 13 by 21 ft. room so that it would be as far away as possible from the control room and would save part of an existing window (see Fig. 3). The portion of the room to the left of the machine was dressing and storage cubicles belonging to the 400 kv. room converted to accommodate a rotating platform with a bed on it. The radiation can be directed downward and outward. Since the floor of the room rests directly on the ground, a strip along the outside wall was the only area to be protected from direct radiation.

By calculation from published tables, it was found that 3 feet of concrete on this wall should reduce the radiation to below 6.25 mr/hr. or the "tolerance" level. The thickness of the existing outside wall was

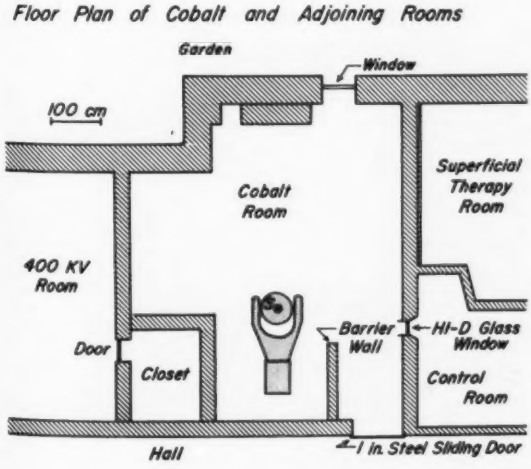

Fig. 3. Floor plan of cobalt and adjoining rooms.

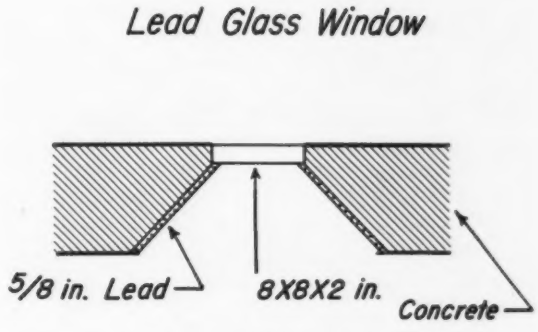

Fig. 4. Details of lead glass window.

22 inches. The part in the path of the direct beam was built up to a thickness of 3 feet. It was made 4 feet wide and 8 feet high. This allowed a margin outside the field for the largest opening and the greatest angle. Four and a half feet of the outside wall is below ground level. The soil takes care of all the stray radiation when the beam is directed downward.

The calculated thickness[1] necessary to reduce the scattered radiation varied from 10 to 12 inches of concrete according to the angle of scatter. It was decided to build up all walls to a thickness of 12 inches of concrete. A boring was made of the ceiling and this was found to be 18 inches thick with 11 inches of concrete equivalent material. Nothing was added.

Atomic Energy of Canada, Limited, recommended a viewing window made of a special lead oxide glass known as Hi D glass,* which has a 55 per cent lead equivalent for Co^{60} radiation. This window, 8 by 8 inches and 2 inches thick, was placed in a specially designed lead box container $\frac{5}{8}$ inch in thickness (Fig. 4). The index of refraction of this glass is very high—1.98—and therefore, even through this small window, one can see almost the entire therapy room.

A 1 inch steel sliding door was recommended between the cobalt room and the hall.

METHOD OF SURVEY

Three different kinds of survey instruments were used: an ionization type for

* Hi D glass is produced by Penberthy Co. in Seattle, Washington.

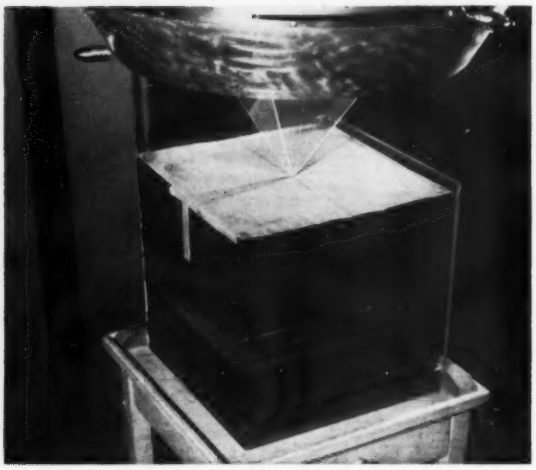

FIG. 5. Setup of cobalt 60 machine with phantom for getting scattered radiation.

values in the 20 mr/hr. region and higher, a Geiger type for values below 20 mr/hr. and an ionization dosage meter for measurements inside the room. All these instruments were calibrated with a known radium standard. For low value readings, correction was made for background radiation and zero adjustment.

The setup for producing scattered radiation is shown in Figure 5 with the beam angled vertically downward. The presdwood phantom is 30 cm. on an edge. The maximum opening, which gave a field of 20 by 20 cm., was used throughout the survey.

When an area like a wall or floor was to be surveyed, it was marked out in 50 cm. squares, and readings were taken every 50 cm. except in areas of rapid change.

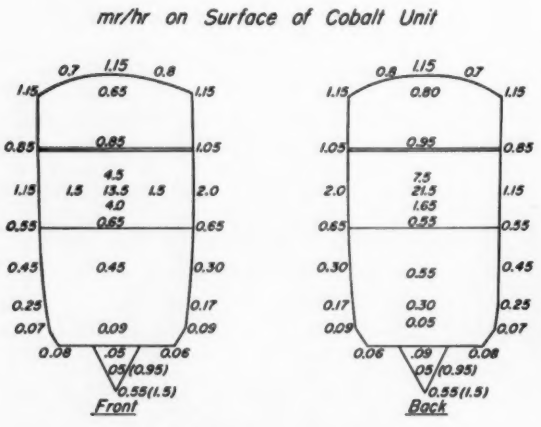

FIG. 6. Stray radiation in mr/hr. on surface of cobalt unit.

RESULTS

The radiation on the surface of the cobalt unit itself is shown in Figure 6. The stray radiation was about 1 mr/hr. or less, except at the end of the drawer, which was pushed into the permanent unit from the dummy shipping container. Here the stray radiation was 13.5 on one side and 21.5 on the opposite side. The figures in parentheses next to the lucite cone give the amount received when the diaphragm was wide open instead of open to only a 5 by 5 cm. port.

In an attempt to find any defects in the cobalt housing which were not picked up by the survey meter, numbered films were wrapped around the unit and left for sixty-two hours. Only three areas of noticeable blackening were found: two on the opposite sides of the drawer and one over the diaphragm opening 5 by 5 cm. square. The blackening on the front of the drawer over the company's name plate is shown in Figure 7. In order to find what caused the five darkened circular areas, the name plate was removed. Corresponding to each darkened area a screw was found recessed into the housing for almost a centimeter. The two darkest areas were directly in line with

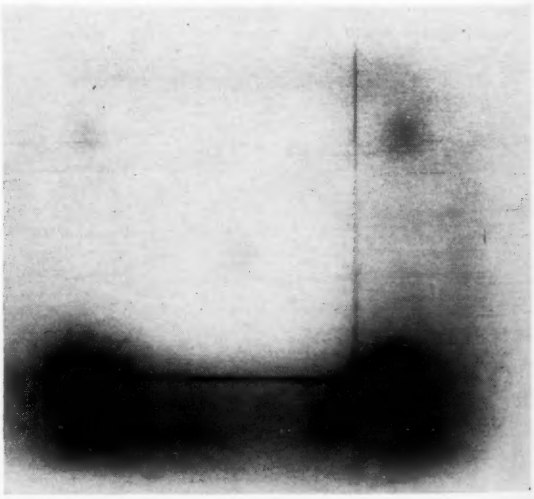

FIG. 7. Blackening on film left over front of cobalt drawer for 62 hours.

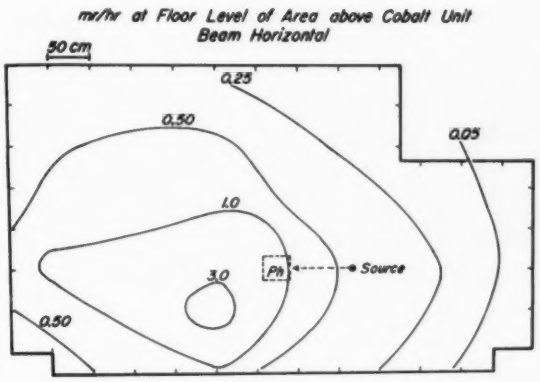

Fig. 8. Stray radiation in mr/hr. at floor level of area above the cobalt unit with the beam directed horizontally.

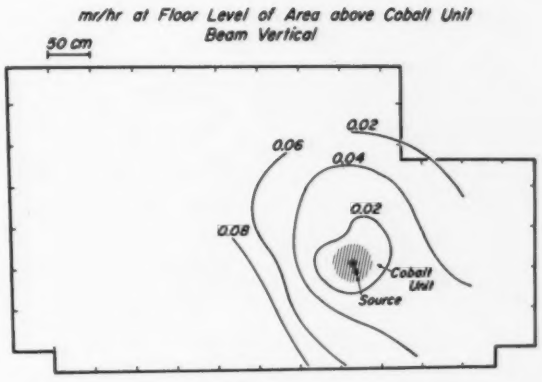

Fig. 10. Stray radiation in mr/hr. at floor level of area above cobalt unit when beam is directed vertically downward.

the cobalt source. The others were above the cobalt.

Room above Cobalt Unit. A careful survey was made of the room directly above the cobalt unit. The floor and a plane parallel to the floor at 50 cm. above it were surveyed with the beam directed vertically down on the phantom and also horizontally against the phantom. Figure 8 shows the stray radiation in mr/hr. at floor level for the beam directed horizontally. Note the elongation of the isostray lines in the direction of forward scatter. Figure 9 shows what was measured under the same conditions 50 cm. above the floor. For the most part, this is below 1 mr/hr.

The stray radiation was measured with the diaphragm giving the maximum field and without the phantom in place. It was found to be from two to seven times less than with the phantom. This was so because the forward scatter from the phantom was greater and more penetrating than the back scatter from the cement wall.

For the beam directed vertically downward the measurements are given in Figure 10. The stray radiation varied from 0.02 mr/hr. to 0.08 mr/hr., which is very little.

Control Room. The location of the cobalt room in relation to the other rooms mentioned in this survey can be seen by referring to Figure 3.

The results of measurement in the control room are shown in Figures 11, 12 and 13. When the beam was directed horizontally, the isostrays ran vertically, increasing in the direction of forward scatter

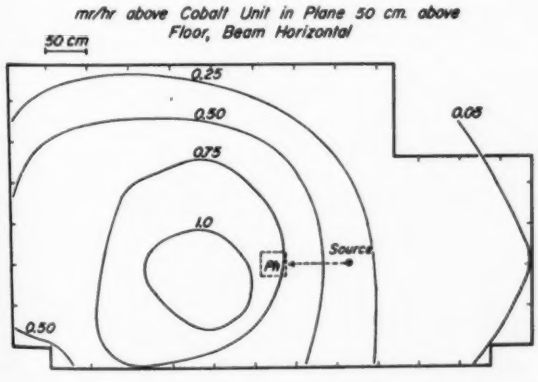

Fig. 9. Stray radiation in mr/hr. 50 cm. above the floor in area above the cobalt unit with beam directed horizontally.

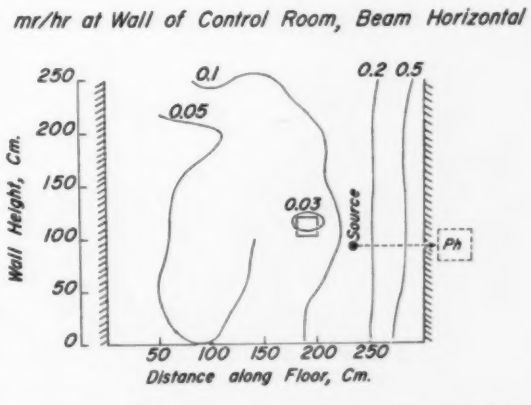

Fig. 11. Stray radiation in mr/hr. at the wall of the control room with the beam directed horizontally before barrier wall was built.

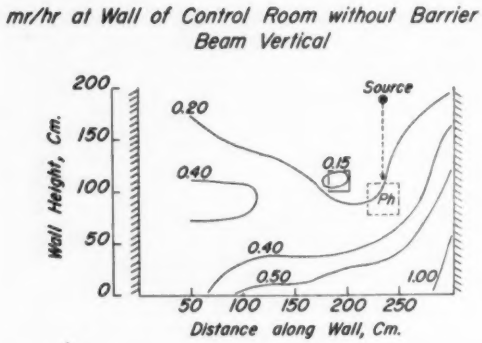

FIG. 12. Stray radiation in mr/hr. at the wall of the control room with the beam directed vertically without the barrier wall.

from 0.05 to 0.5 mr/hr.; when the beam was directed vertically the isostrays were in a horizontal direction, ranging from 0.2 to 0.5 mr/hr. The personnel who occupied the control room and those who worked with the cobalt were monitored by means of direct reading pocket dosimeters and film badges. The average on the pocket dosimeters was 1 mr/day, which is only slightly higher than the natural leak of the instrument. The dosimeters of the physicists sometimes registered 2 mr/day. The film badges had less than a measurable amount in each two week period, which is less than 20 mr for this type of film badge.

Note that less stray radiation got through the Hi D glass window than through the surrounding wall. The absorption of this window was measured, and the attenuation

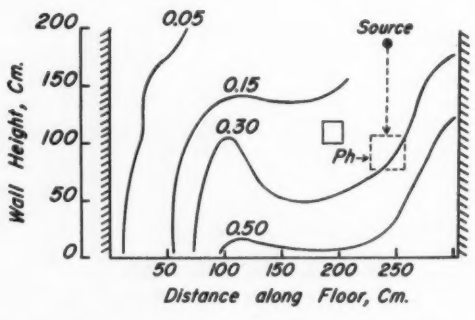

FIG. 13. Stray radiation in mr/hr. at the wall of the control room with the beam directed vertically after the barrier wall was built.

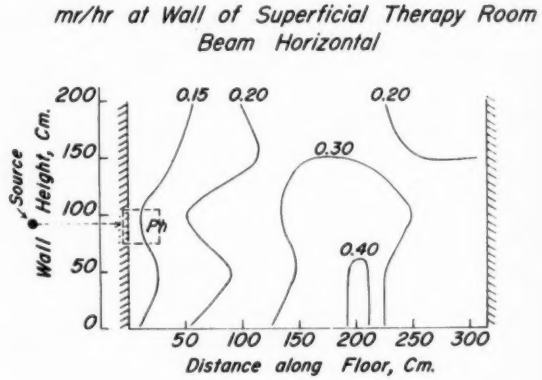

FIG. 14. Stray radiation in mr/hr. at the wall of the superficial therapy room when the beam is directed horizontally.

factor was found to be 500 when the beam was directed vertically downward. When the beam was directed horizontally, the attenuation factor was 3,800. The half-value layer in copper of this scattered beam was found to be 4 mm., which would mean that the scattered radiation was equivalent to about 400 kv. radiation. That for the vertically directed beam was much harder.

Superficial Therapy Room. The wall of the superficial therapy room is a continuation of the wall of the control room. The results of the survey are shown in Figures 14, 15 and 16. One would expect that the isostrays when the beam was directed horizontally (Fig. 14) would have been higher here than in the control room, for the radiation scattered through a smaller angle struck this wall, and this radiation is

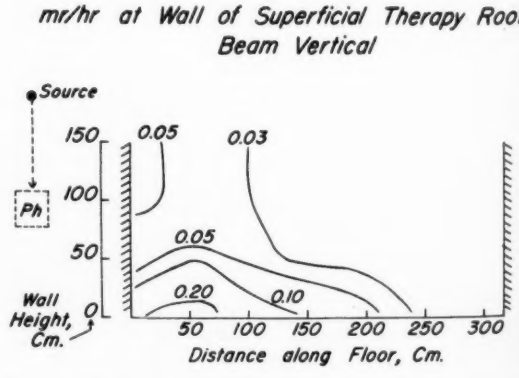

FIG. 15. Stray radiation in mr/hr. at the wall of the superficial therapy room when the beam is directed vertically.

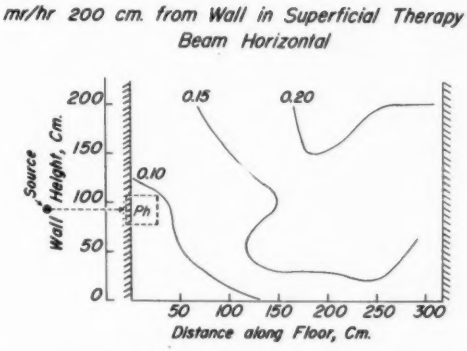

Fig. 16. Stray radiation in mr/hr. 200 cm. from wall of the superficial therapy room where technician might stand when the beam is directed horizontally.

more penetrating and more intense. However, this wall had 3 mm. of lead on it as part of the protection of the superficial therapy room. The isostrays were vertical in direction and increased in the direction of forward scatter up to a maximum of 0.4 mr/hr.

When the beam was directed vertically, the isostray values were lower and ran in a horizontal direction from 0.05 to 0.2 mr/hr.

400 kv. Room. On the opposite side of the cobalt room from the superficial therapy room is the 400 kv. room. Figures 17, 18 and 19 show the isostrays at the wall and 180 cm. from the wall, where the 400 kv. technician might stand. In Figure 17, with the beam directed vertically, the stray radiation on the left of the wall "through" the phantom is 0.1 mr/hr. and on the other side is 0.02 or less. This is so because here the radiation had to penetrate through two 12

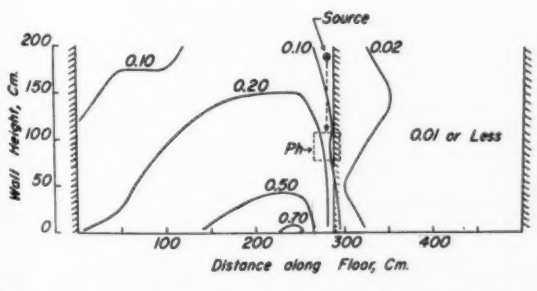

Fig. 17. Stray radiation in mr/hr. at the wall of the 400 kv. room with beam directed vertically.

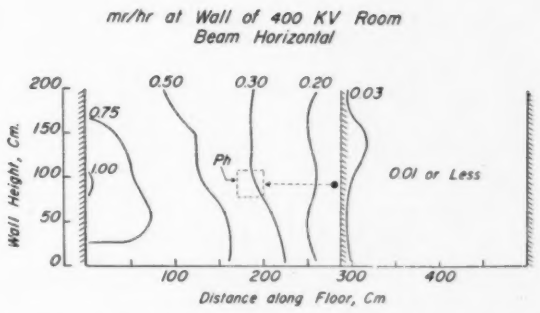

Fig. 18. Stray radiation in mr/hr. at the wall of the 400 kv. room with the beam directed horizontally.

inch walls of the closet adjoining the 400 kv. room. The curves bring out what one should accept without reservation, that 24 inches of concrete is more protective than 12.

At 180 cm. from the wall, the radiation was less except in the part of the plane parallel to the closet, where it was slightly higher, 0.05 mr/hr. compared to 0.01 mr/hr. This was so because one was no longer directly in the shadow of the two thicknesses of closet walls.

Hall. The survey of the hall with the beam directed horizontally toward the opposite wall is shown in Figure 20. There was very little stray radiation, 0.05 mr/hr., directly behind the machine. It was higher on either side; through the steel door it was higher than on the opposite side through the concrete although it was still below the permissible amount.

When the beam was directed vertically,

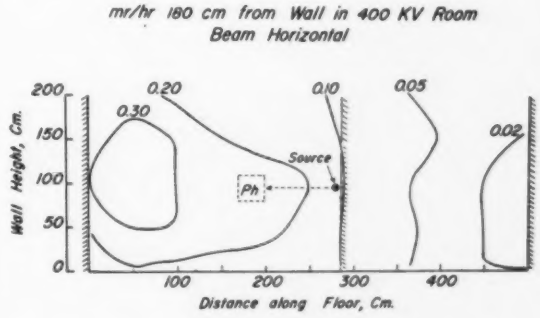

Fig. 19. Stray radiation in mr/hr. 180 cm. from the wall in the 400 kv. room with the beam directed horizontally.

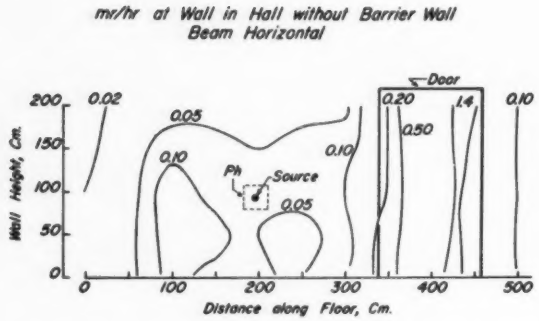

FIG. 20. Stray radiation in mr/hr. at the wall in hall without barrier wall when beam is directed horizontally.

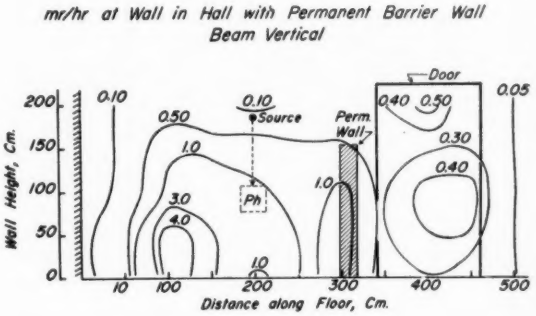

FIG. 22. Stray radiation in mr/hr. at the wall in hall with permanent barrier wall beam directed vertically.

the stray radiation was much higher, as is seen in Figure 21. Here too, it was least behind the machine, 1 mr/hr., and greater on either side. Ten to 15 mr/hr. got through the 1 inch steel door. In an attempt to reduce this, an experimental barrier wall was built of hollow cinder blocks. Each block, $3\frac{1}{2}$ by 9 by 17 inches, was placed with the 17 inch dimension in the path of the radiation so the stray radiation had to penetrate the four partitions, each about 1 inch thick, of the three-cell block. The wall was made 5 feet high and 5 feet long. If it had been longer, the view from the control room window to the patient would have been obstructed. One could not foretell whether such a short wall would have much effect on the stray radiation at the farther side of the door. The stray radiation through the door was remeasured and it was reduced by a factor ranging from 17 to 25, and "average" of 20. From Dixon's curve[1] the amount of concrete necessary to reduce the scattered radiation by a factor of 20 was found to be 7 inches. The cinder block wall was removed and an 8 inch concrete wall was built. The reduction factor through the door ranged from 20 to 55. The survey of the wall in the hall with this permanent barrier is shown in Figure 22. At the door, the stray radiation was 0.3 to 0.4 mr/hr. instead of 10 to 15 mr/hr.

A resurvey of the control room after the barrier wall was constructed, with the beam directed vertically, is shown in Figure 13. The radiation was decreased in the shadow of the barrier wall.

Inside Cobalt Therapy Room. The stray radiation in a horizontal plane through the center of the phantom at 92 cm. from the floor with the beam directed vertically downward is shown in Figure 23. The stray radiation varied from 2,000 mr/hr. at 80

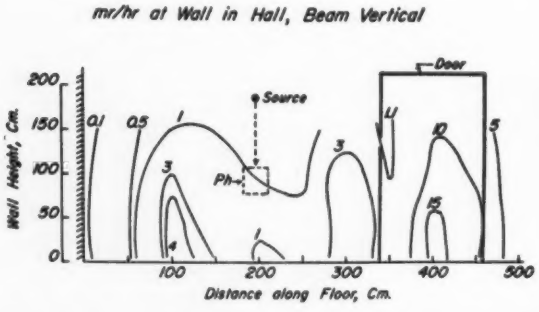

FIG. 21. Stray radiation in mr/hr. at the wall in hall without barrier wall with beam directed vertically.

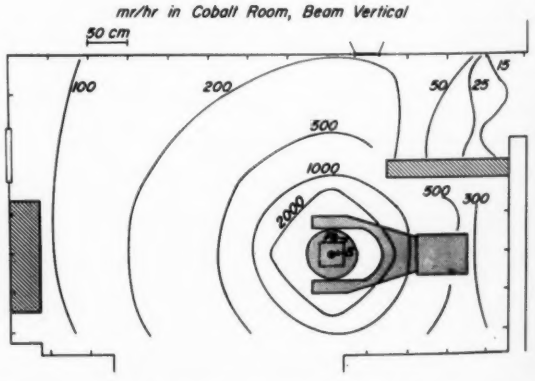

FIG. 23. Stray radiation in mr/hr. in cobalt room in a horizontal plane through the center of the phantom with the beam directed vertically.

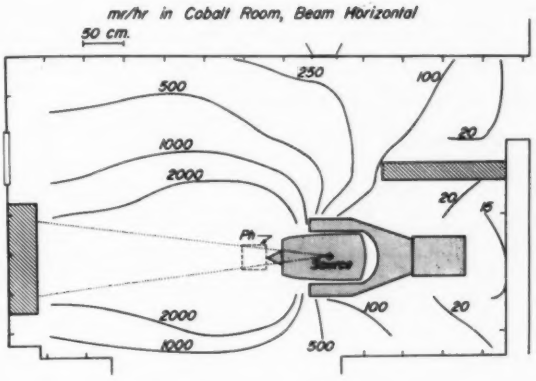

FIG. 24. Stray radiation in mr/hr. in cobalt room in a horizontal plane through the center of the phantom with the beam directed horizontally.

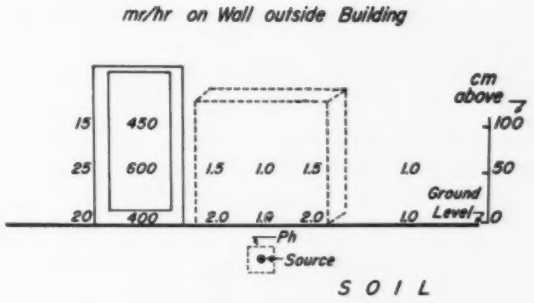

FIG. 25. Stray radiation in mr/hr. on wall outside building.

cm. from the phantom to 100 mr/hr. at 360 cm. Note how the barrier wall changed the shape of the isostrays. The 300 to 500 mr/hr. lines were changed to 15 to 50 mr/hr. by the barrier wall.

The stray radiation measured inside the cobalt room when the beam was directed horizontally is given in Figure 24. Here the scatter was in a forward direction, elongating the isostray lines. The scatter near the door was about 20 mr/hr.

Outside the Building Wall. On Figure 25 is shown what was measured outside the building above ground level when the beam was directed horizontally toward this wall. All of this was stray radiation, for the upper edge of the field was 5 cm. below ground level. The large amounts—400 to 600 mr/hr.—indicate what went through the window into an unoccupied garden.

When the head was positioned so that the direct beam went through the wall above ground without the phantom in place, the direct radiation measured 4 mr/hr. outside the building.

DISCUSSION

The design for the protection of each cobalt installation is an individual problem. However, certain conclusions can be drawn from our measurements and experience. The 12 inch concrete walls and ceiling are adequate for scattered radiation. The 8 by 8 by 2 inch thick Hi D glass window offers adequate vision and excellent protection. The 3 foot outside wall is adequate for direct radiation.

Whenever possible, it is advisable to use a concrete barrier maze near the door through which the patients enter. The stray radiation inside our steel door after the barrier wall was built measured between 15 and 20 mr/hr. To reduce this by a factor of 10,[1] one needs 11 mm. of lead; to reduce the stray to 6.25 mr/hr., only 4 mm. of lead. An ordinary lead door would have been sufficient instead of an intricate motor-driven one.

One might question the use of a Geiger tube survey instrument, calibrated with gamma rays for measuring stray radiation, and calling the result milliroentgens, since this type of instrument is wavelength dependent. The "soft" stray radiation measured inside the room had a half-value layer of 4 mm. Cu, which would put its kilovolts range in the region of 400. According to the National Bureau of Standards,[2] this particular type of Geiger instrument may vary as much as 70 per cent between the 400 kv. region and 1,200 kv. region. The radiation, however, which gets through the concrete is hardened and therefore the correction for the radiation measured outside the room is less.

The Geiger survey meter used in this investigation was compared with a different "make" Geiger type survey meter, calibrated independently at another laboratory. On the 0.2 scale the two instruments differed by 15 per cent when checked with

a radium standard and by 10 per cent when exposed to the same stray radiation from the cobalt unit. Therefore, I think that the use of mr/hr. is justified provided one does not expect an accuracy greater than 30 to 40 per cent from stray radiation measurements.

The measurements in this paper were repeated using the same instruments and did not vary more than 10 per cent.

SUMMARY

1. The design of the protection for a room to house a cobalt 60 beam therapy unit with an output of 32 r per minute at 80 cm. source skin distance is illustrated.

2. Isostray curves are drawn for all occupied areas, with the direct beam striking the scattering medium vertically or horizontally.

3. Isostray curves are drawn for the scattered radiation inside the room, with the beam in the horizontal and in the vertical directions. These curves can serve as a guide in calculating the thickness of wall needed for protection at various distances from the cobalt unit.

4. The attenuation factor through the special lead oxide glass window, known as Hi D glass, was measured for the beam scattered when the radiation was directed vertically against the phantom and horizontally, the scattering angle being different in each case. It was found to be 3,800 for the scatter from the horizontal beam and 500 for the scatter from the vertical beam. The half-value layer of the former stray radiation measured 4 mm. Cu.

5. To find how much protection a barrier wall would give to the steel door, an experimental wall was built of movable cinder blocks. The attentuation factor was measured and found to be more than adequate.

6. A barrier wall of concrete 8 inches thick was built. The attenuation of stray radiation was measured. It is recommended that where possible a maze of concrete be built leading to the entrance to the room. This obviates heavy and expensive doors.

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We wish to thank Mr. George Ross for his help with the diagrams and Dr. J. R. Freid, Chief of the Radiotherapy Department, for his interest and cooperation in this investigation.

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THE INFLUENCE OF ROENTGEN IRRADIATION ON THE DEVELOPMENT OF THE EYE OF THE AXOLOTL*

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INTRODUCTION

IN PREVIOUS work on local roentgen irradiation of parts of the body, a special sensitivity of particular organs was observed in some cases. For example, a special sensitivity to irradiation was observed in the enamel organs of teeth after local irradiation of the jaws of young axolotls. In the head of axolotls the most sensitive parts were the eyes.

The purpose of this paper is to describe the influence of local roentgen irradiation on the development of the eye of the young axolotl. A comparison will be made with the effect of roentgen treatment on the eyes of young mice and the significance of the data for practical roentgenology will be discussed.

Desjardins[18] gave an excellent review of the older literature concerning the influence of roentgen rays upon the eye. Chalupecky[13] irradiated a rabbit and concluded that roentgen rays cause severe destructive changes in the structures of conjunctiva, cornea and iris. Baermann and Linser[1] irradiated a cornea of a rabbit but the effect was not observed. Birch-Hirschfeld[4] exposed one eye of several rabbits. He described the necrosis and desquamation of the cornea and slight changes in the retina. Tribondeau and Récamier[44] described the influence of roentgen rays upon the development of the eye of a kitten three days after birth. They observed degeneration of the lens, but normal development of the layer of rods and cones, atrophy of internal granular layer and an intense proliferation of the external granular layer. Belley[2] studied the effect of local roentgen irradiation on the development of the eyes of newborn kittens. Cataract formation in the lens and development of abnormal folds in the retina were observed. Tribondeau and Belley[45] observed in irradiated newborn kittens lens degeneration and formations of folds in outer layers of the anterior half of the retina. Von Hippel[24] irradiated rabbits in utero and observed in many embryos the formation of bilateral cataract. Tribondeau and Lafargue[46] investigated the action of roentgen rays on the eye of adult animals and concluded that the fully developed eye is resistant to the radiation. Bossuet[5] observed the effect of roentgen rays on the lens of fetal, newborn, and adult guinea pigs, rabbits and dogs. He concluded that roentgen rays injure the growing lens of young animals much more than the lens of the adult. Pagenstecher[33] irradiated rabbits in utero and observed folds and rosette formation in the retina. Frogé[19] exposed young rabbits (2–4 weeks old) to different doses of roentgen rays and observed various degrees of cataract formation and development of folds in the retina. Rados and Schinz[35] described the effect upon the eye of adult rabbits of a large dose of roentgen rays and concluded that this organ is very resistant to irradiation. (See also Rollet and Malot[36] and Hughes and Iliff.[25]) The author of a recent review on the influence of roentgen rays upon the eye (Cogan[14]) also concluded that the retina is very resistant as is the nervous system in general. Only in rare cases is it possible to see an effect of irradiation upon the retina of adult animals. Cogan thought that in these cases the primary damage occurred, not in the retinal cells, but in the blood vessels of the retina. The experiments, however, of Tribondeau and Belley,[45] Pagenstecher[33] and Frogé[19] described various types of

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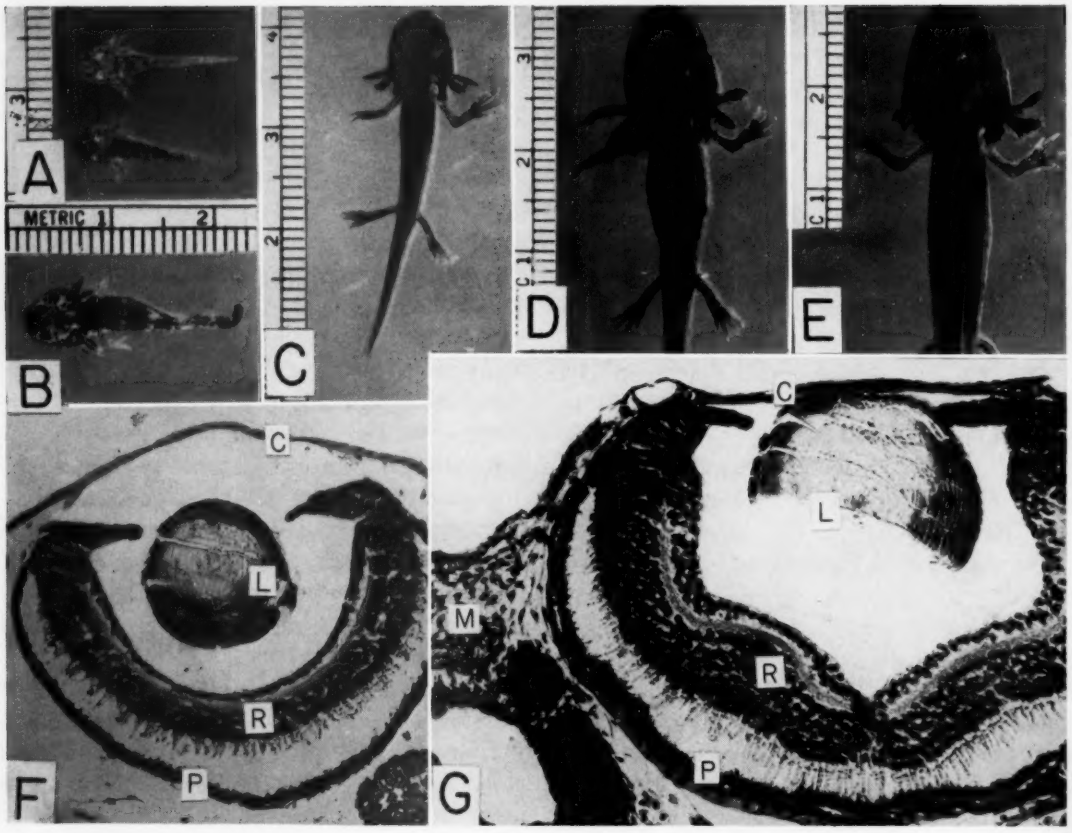

FIG. 1. (*A*) (*B*) Photographs showing the appearance of the animals of two experimental groups on the day of irradiation. (*A*) Younger group, treatment 9 days after hatching. (*B*) Older group, treatment 16 days after hatching. (*C*) An animal 35 days after irradiation of the anterior part of the head with 8,000 r (irradiation 26 days after hatching). The suppression of development of the treated region is clear. (*D*) A control animal the same age as animal in (*C*) (*E*). An animal 26 days after irradiation of the left anterior portion of the head with 5,000 r (irradiation of left eye and surrounding tissue of animal 65 days after hatching). Difference between left and right eyes is obvious. (*F*) A medial section through the eye of an animal 9 days after hatching. Photomicrograph ×106. (*G*) A medial section through the eye of an animal 16 days after hatching. Photomicrograph ×106.

C, cornea; L, lens; M, mesenchyma; P, pigment layer of choroid; R, retina.

damage to retinal cells of young animals. Also Demel[17] has described rosette formation and other damage to the retina of dogs treated when they were four days old. Birch-Hirschfeld[4] and Jacoby[26] described degeneration of some of the ganglion cells and granular disintegration of the outer portion of the rods and cones layer in treated eyes. Spear[42] observed degeneration only in the "undifferentiated layers of the retina" in the eyes of rats irradiated two days after birth. Rugh[37,38] described a dis-

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FIG. 2. Inhibition of growth and development of eyes after roentgen irradiation. (*A*) The eye of an animal 58 days after irradiation with 4,000 r (treatment 16 days after hatching). Photomicrograph ×106. (*B*) The eye of an animal 68 days after irradiation with 4,000 r (treatment 16 days after hatching). Photomicrograph ×106. (*C*) The eye of control animal from the same spawning, 84 days after hatching. Photomicrograph ×106.

C, cornea; EC, eye cartilage; L, lens; P, pigment layer of choroid; R, retina.

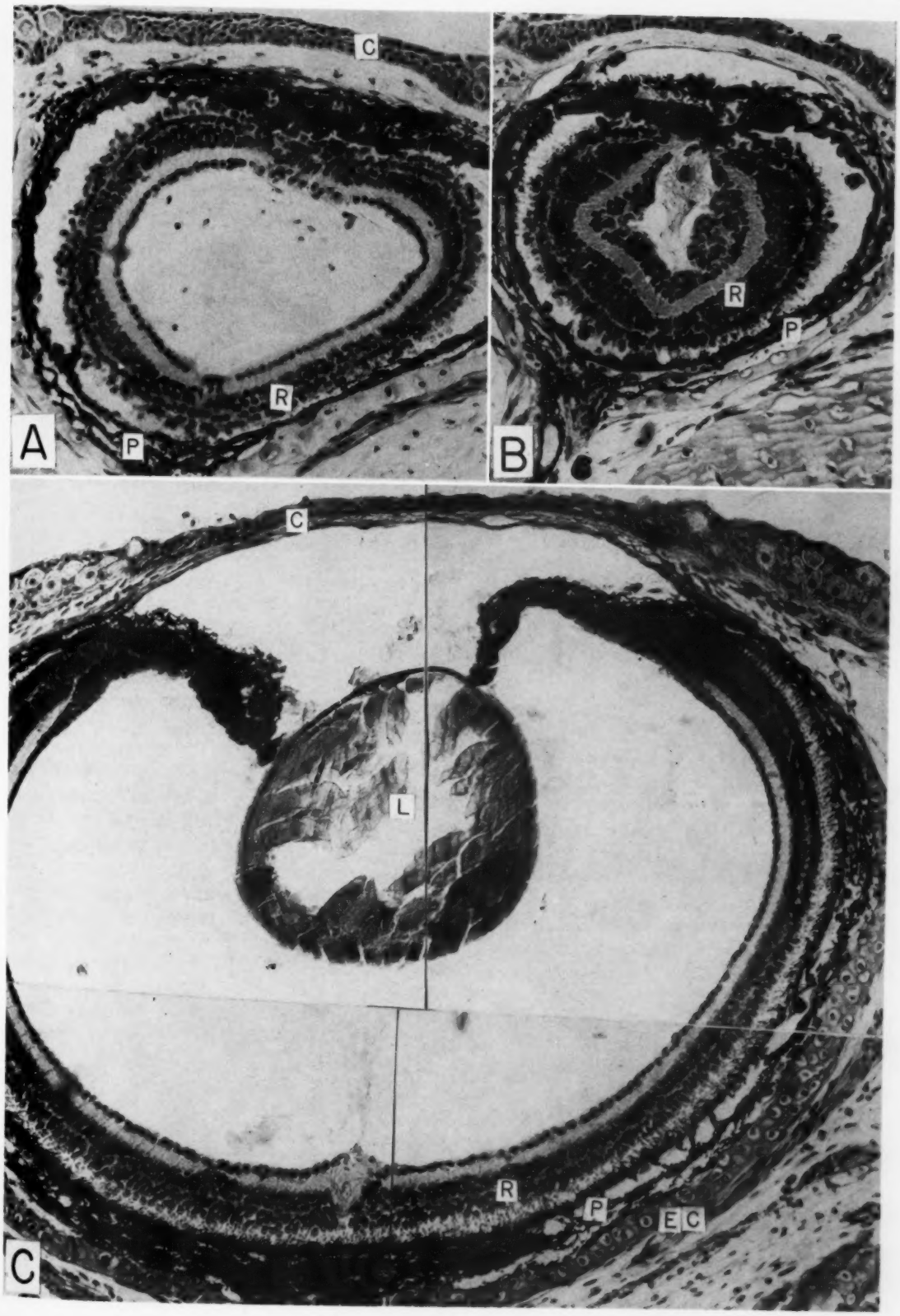

Fig. 2

arrangement of the retinal cells in *Amblystoma opacum* after irradiation with 15,000 r and "significant changes in the retina" of irradiated squid. Abelsdorff (see Warren[47]) reported the disappearance of the layer of rods and cones after injecting into the eye an amount of thorium X equivalent to 0.1 mg. or more of radium bromide. The paper of Lorenz and Dunn[30] is especially interesting. These authors showed that the eye of newborn mice is very sensitive to roentgen irradiation. Even after treatment with relatively small doses (400 r) the layer of rods and cones disappeared. They compare the sensitivity of the eye of newborn mice with the well known sensitivity of gonads (see also Kosaka[28]).

MATERIALS AND METHODS

One hundred and twenty-five axolotls (*Siredon mexicanum*) were used for this investigation (75 animals were irradiated and 50 served as untreated controls). The doses varied from 1,000 to 8,000 r and the ages of the animals on the day of treatment were from nine to sixty-five days after hatching. Most of the animals were treated with 4,000 to 5,000 r at the age of nine to seventeen days after hatching (Fig. 1, *A* and *B*).

The conditions of irradiation were as follows: 3 ma., 55 kv. (peak), no filter, 104 r per minute. The target-object distance was 10 cm. The animals were anesthetized before irradiation by means of water solution of M.S. 222 tricaine methanesulfonate. The animals were shielded with a lead table made of 4 mm. lead sheet and having a localizer slit 4 mm. wide (see Brunst[10]).

The material was fixed in saturated solution of bichloride of mercury with 5 per cent acetic acid, and imbedded in paraffin. Frontal sections were made at 10 microns and stained with Ehrlich's hematoxylin and eosin.

RESULTS

Investigation of animals fixed on the day of irradiation showed that even the smallest ones (9 days after hatching) had differentiated and functional eyes (Fig. 1, *F*). The differentiation of the eye sixteen days after hatching is much further advanced (Fig. 1, *G*).

The changes in coloration of the treated region and the suppression of growth were obvious eighteen days after irradiation with 8,000 r and twenty six days after irradiation with 4,000 r. The difference between the treated and control animals thirty-five days after irradiation with 8,000 r is clear (Fig. 1, *C* and *D*). Even after irradiation of one eye and the surrounding tissues on only one side of the head in animals sixty five days after hatching, the result of treatment was clearly seen very early. For example, the suppression of the development of the treated eye is evident twenty six days after such irradiation (Fig. 1*E*). If the irradiation was administered to young animals and the dose of roentgen rays was large enough, the gradual disappearance of the eyes was observed in all cases.

Microscopic examination of the eyes showed a great difference in size and structure between the treated and the control animals. This difference was clear even in the cases where the effect of the irradiation was comparatively less drastic. In these animals the development of the eyes was greatly suppressed, but there was only partial destruction and disorganization of the eye component (Fig. 2). The inhibition of the development of the eye and also the comparatively large size of the cell are typical for the primary irradiation damage. For example, the cells of the cornea or retina are much larger in the treated animals than in controls (Fig. 2, *A*, *B* and *C*). It is very possible that this phenomenon is closely related to the process of the formation of giant degenerating cells which is characteristic of irradiation damage in

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FIG. 3. Degeneration and reduction of the eyes after roentgen irradiation. (*A*) The eye of an animal 28 days after irradiation with 8,000 r (treatment 27 days after hatching). Photomicrograph ×106. (*B*) The rudiment of the eye of an animal 128 days after irradiation with 4,000 r (treatment 53 days after hatching). Photomicrograph ×106. (*C*) The rudiment of the eye of an animal 36 days after irradiation with 8,000 r (treatment 26 days after hatching; see Fig. 1*C*). Photomicrograph ×106. (*D*) *and* (*E*). The rudiments of the eyes of an animal 178 days after irradiation with 4,000 r (treatment 53 days after hatching). Photomicrograph ×106.

C, cornea; EC, eye cartilage; L, lens; P, pigment layer of choroid or accumulation of pigment cells; R, retina.

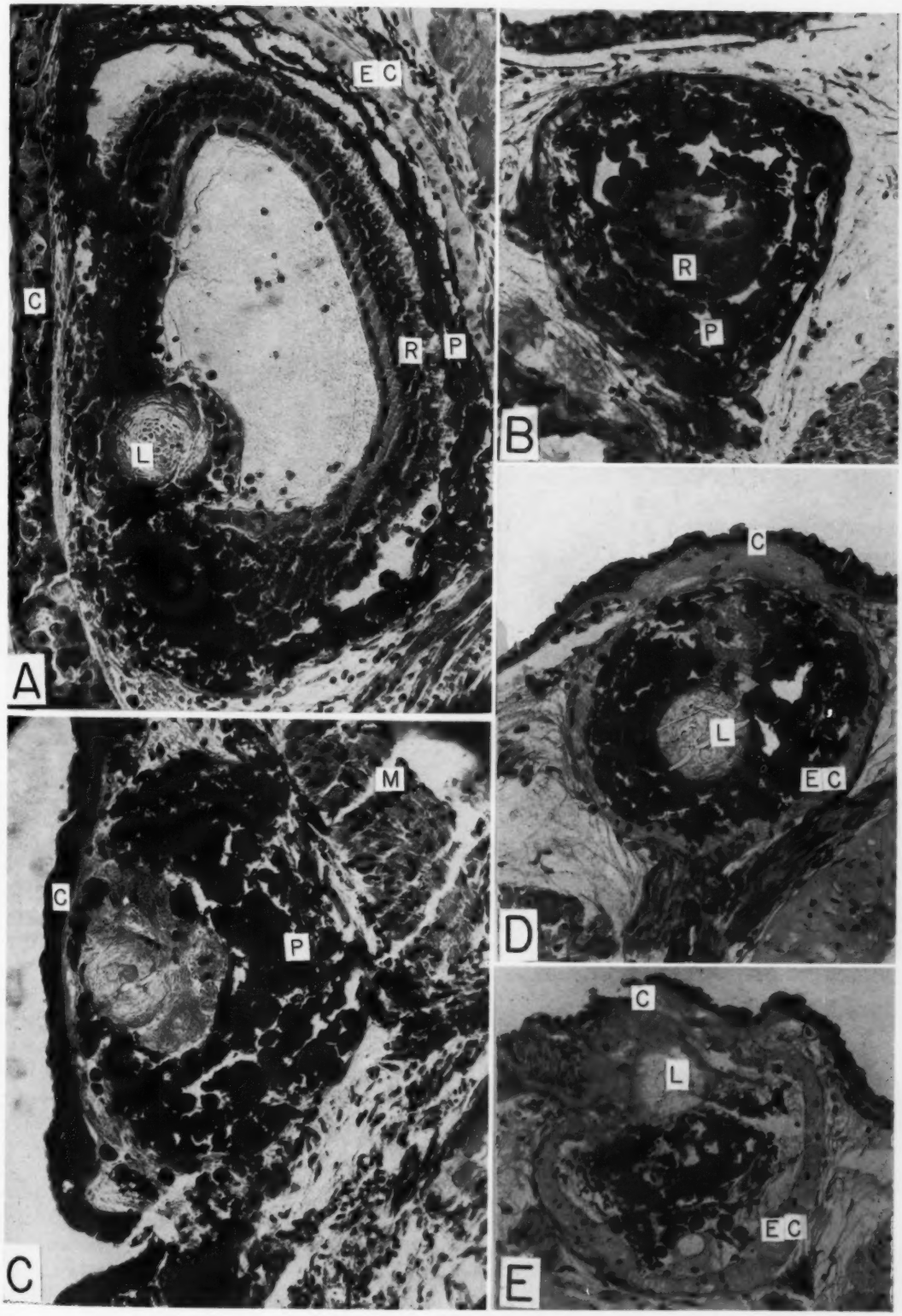

Fig. 3

general (Cramer,[15] Helwig,[22] Torrioli and Fiorentini,[43] Pietschmann,[34] Dererer,[16] Luther,[32] Lasnitzki,[29] Hall and Friedman,[20] Brunst,[6,7] Brunst, Barnett and Figge,[9] Schneller,[41] Harrington and Koza,[21] Brunst, Sheremetieva-Brunst and Figge,[11] Rugh, Levy and Sapadin[39]). Obviously, the ability of cells for multiplication is suppressed by roentgen treatment, but during this period the metabolism may be only partially suppressed and the cells continue to grow and reach a comparatively large or even giant size. At the same time, however, the most sensitive cells had died and disappeared completely. The destruction of some cells in the retina is especially clear in the photomicrographs of sections through the eyes fifty-eight and sixty-eight days after irradiation with 4,000 r (Fig. 2, *A* and *B*). It is obvious that most of the rod and cone cells had disappeared.

The pigment cells of choroid always react in a typical way to irradiation of the eye. Soon after irradiation, abnormal accumulation of pigment cells was observed in the anterior portion of the retina and the iris near the lens (Figs. 2, *A* and *B* and 3 *A*). The pigment cells are the most resistant cells in the eye and therefore they do not decrease in number even during the complete degeneration of the eye after roentgen treatment. They do, however, change their shape. Instead of showing their typical form with numerous processes they become in most cases globular. Such an appearance of pigment cells is characteristic of irradiated tissues in general and was observed in almost all investigations (see Brunst,[6,7] Brunst, Barnett and Figge[9]). But after such changes, the degenerative pigment cells in most cases disappeared completely. Such a disappearance of pigment cells was observed in the skin region of the anterior part of the head twenty-eight days after irradiation. However, in the eye these pigment cells never disappeared completely, but were concentrated in the center of the eye. This process of concentration of all pigment cells appeared exaggerated because of the simultaneous degeneration of all other components of the eye. Thus, after complete reduction, the rudiments of the eye consist only of a concentrated accumulation of pigment cells (Fig. 3, *B*, *C*, *D* and *E*). It is noteworthy that these pigmentary rudiments of the eye when observed long after the irradiation do not undergo further change (Fig. 3, *D* and *E*). It is interesting to compare this resistance of pigmentary eye rudiments with the reduction of teeth, which disappeared very quickly after irradiation. One hundred days after treatment it was impossible to find in the irradiated jaw of the axolotl any remnants or rudiments of teeth (Brunst, Sheremetieva-Brunst and Figge[11]).

The damage to the lens was observed at the time of the primary changes in the eye after roentgen treatment. The lens in some instances was very large (Fig. 3 *A*), but this was obviously the result of degenerative hypertrophy of the surface cells of the lens. Later the lens often became reduced in size, in some cases took a central position in the eye (Fig. 3*D*) and gradually completely disappeared (Fig. 3, *B* and *C*).

It was mentioned that the retina contained some of the most radiosensitive cells, which disappeared in some cases as early as eighteen days after treatment. It is very interesting that in some instances the eyes were only slightly damaged by irradiation and the retina at low magnification appeared almost normal (Fig. 4*A*). This was observed when a comparatively small dose (2,000 r) was given or if irradiation was administered to relatively old and large animals (for example, 65 days after hatching). But the photomicrograph of the same retina at high magnification shows clearly that the layer of rods and cones is greatly reduced (Fig. 4*B*). This is especially evident from a comparison of this picture with a photomicrograph of a normal retina of a control animal taken at the same magnification (Fig. 4*C*). After irradiation of young animals with larger doses (4,000–5,000 r) there is almost a complete absence of the layer of rods and cones. This is evident from the photomicrographs (Fig. 4*D* and Fig. 6*B*). In all cases the rods and cones layer disappeared first, and consequently it is clear that this layer in animals of this age is the most sensitive to roentgen irradiation. In the final postirradiation degeneration only a small rudiment of the retina sometimes remained (Fig. 3*B*) or the cells of the retina disappeared entirely (Fig. 3, *C* and *D*) and the rudiments of the eyes consisted mainly of degenerated pigment cells.

The mechanism of such a rapid disappearance of almost all parts of the eye after roentgen irradiation is not entirely clear. According to our previous observations, in all cases of rapid reduction of irradiated parts the phagocytic activity of giant cells (macrophages) were im-

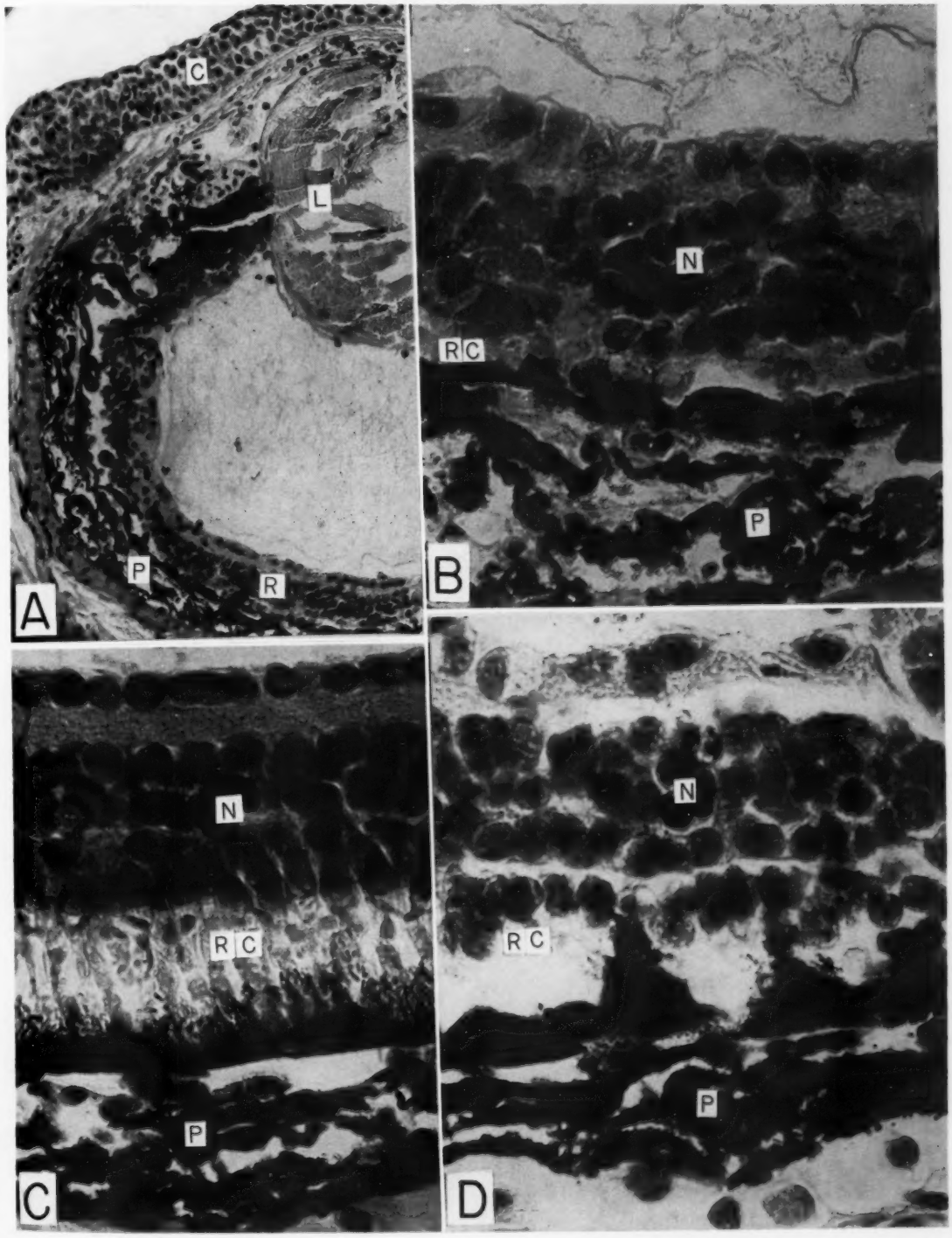

Fig. 4. The influence of roentgen irradiation upon the structure of the retina. (*A*) The eye of an animal 29 days after irradiation with 5,000 r (treatment 65 days after hatching; see Fig. 1*E*). Photomicrograph ×106. (*B*) The retina of the eye shown in (*A*). The rods and cones layer (RC) almost absent. Photomicrograph ×500. (*C*) The retina of a control animal fixed 61 days after hatching. Photomicrograph ×500. (*D*) The retina of an animal 36 days after irradiation with 5,000 r and 53 days after hatching. The rods and cones layer greatly reduced. Photomicrograph ×500.

C, cornea; L, lens; N, nuclear layers of the retina; P, pigment layer of choroid; RC, rods and cones layer of the retina.

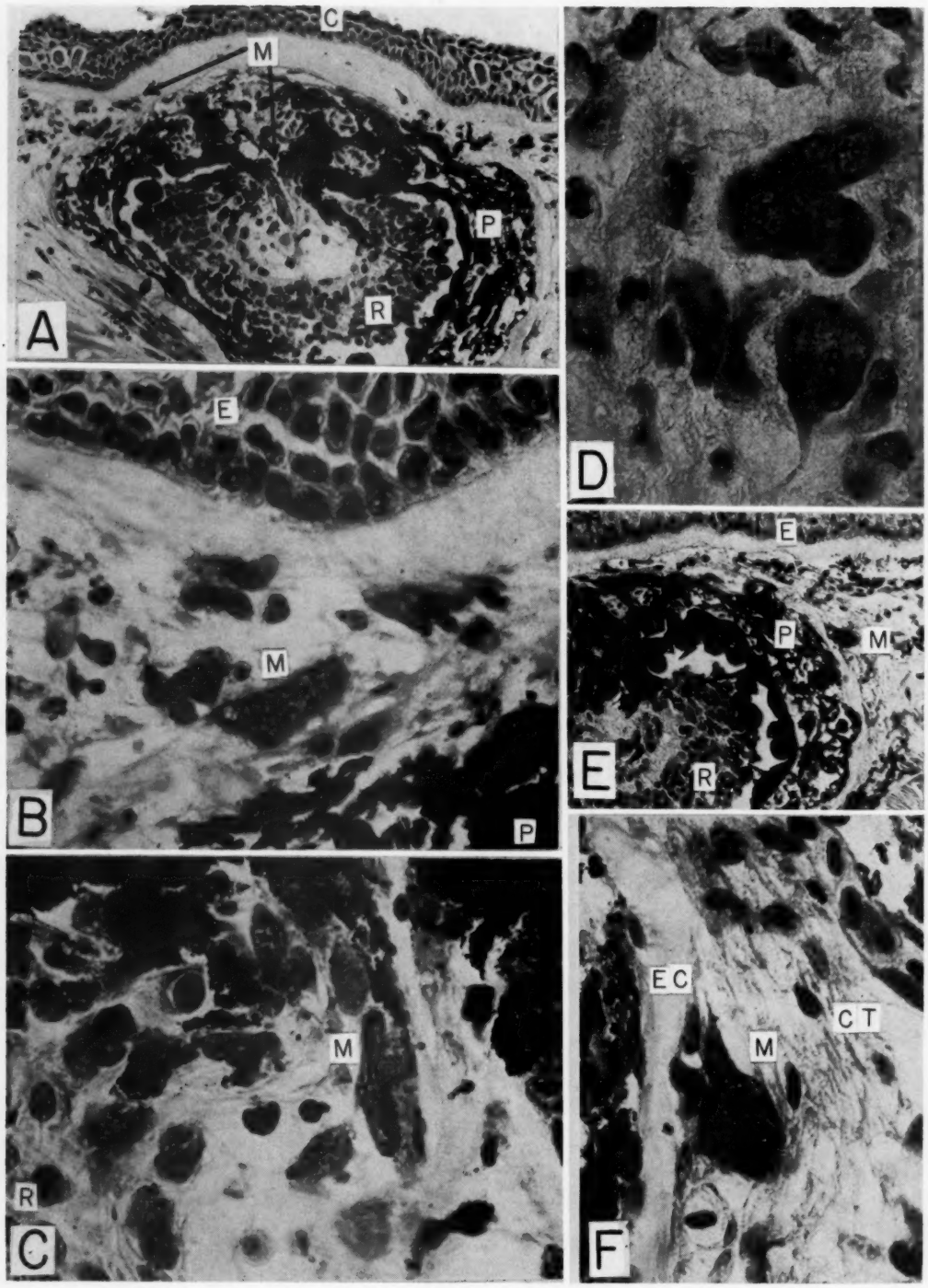

FIG. 5. (*A*) Frontal section through the head of animal 55 days after irradiation with 4,000 r and 70 days after hatching (treatment 15 days after hatching). General picture of penetration of macrophages into the eye. Photomicrograph ×106. C, cornea; M, macrophages; P, pigment layer of choroid; R, retina. (*B*) Frontal section through the head of the same animal as that in (*A*). Macrophages near the eye. Photomicrograph ×500. E, epithelium; M, macrophages; P, pigment cells. (*C*) Frontal section through the head of the same animal as that in (*A*). Penetration of macrophages into the eye. Photomicrograph ×500. M, macrophages; P, pigment cells; R, retinal cells. (*D*) Frontal section through the head of animal 27 days after irradiation

portant (Brunst,[8] Brunst, Sheremetieva-Brunst and Figge[11]). Probably this is true for the present material also. Numerous observations have shown that the macrophages were very active during the primary acute reaction in the irradiated head (Fig. 5*D*). In some cases the macrophages were observed near and even penetrating into the eye rudiment (Fig. 5, *A*, *B*, and *C*). Isolated macrophages were observed near the eye rudiment not only during the primary acute reaction but even long after the end of this period (Fig. 5, *E* and *F*).

DISCUSSION

It would be desirable to know the factors responsible for such special sensitivity of the eyes to roentgen irradiation.

The microscopic examination of the eyes taken from the animals of various ages showed that a great difference exists between the eyes at various stages of development. The great contrast between the structure of the retinas of normal animals nine and 220 days after hatching can be seen on the photomicrographs (Fig. 6, *A* and *C*). The eyes of an animal nine days after hatching have a retina in the early stages of differentiation. The rods and cones layer and choroid are very thin (Fig. 6*A*). The eye cartilage, typical of the adult eye of the axolotl (Fig. 6*C*), is absent in an animal nine days after hatching. In spite of the similarity of the retina of an animal sixteen days after hatching (Fig. 1*G*) to that of an adult animal, a great difference was observed in the structure and thickness of the choroid and of the eye cartilage. In the cells of the retina of such sixteen day old animals mitotic figures were observed. It is noteworthy that instead of differentiated loose connective tissue, near the eye of the animal of this age, typical embryonic mesenchyme was observed (Fig. 1*G*). These observations justify the conclusion that the eyes of animals used for this investigation are organs in the process of differentiation and active growth and are, therefore, according to the law of Bergonié and Tribondeau,[3] sensitive to roentgen irradiation.

It is interesting that Lorenz and Dunn[30] reached the same conclusion. They described a special sensitivity to roentgen treatment of the eyes of newborn mice, and concluded that the tissues of the eye in the newborn mouse are in the process of active growth and differentiation and therefore, sensitive to irradiation. It is interesting, however, that they observed no damage to the eyes after irradiation of mice two months old. Also Lorenz and co-workers[31] observed the effect on the eyes after roentgen irradiation of adult mice, guinea pigs or rabbits of three to five months of age, in spite of the fact that doses were between 6,000 and 12,000 r. If we compare with this the effect of the relatively small doses (400 r) in newborn mice which completely destroyed the layer of rods and cones, the importance of the age factor in biological effect of roentgen irradiation will be clear. The results of Lorenz and Dunn[30] have thus been confirmed by other observations (Brunst and Figge[12]) According to these, after irradiation of mice one to three days old with 3,000 r, clear evidence of damage was observed only in the retina of treated eyes in which the layer of rods and cones was completely destroyed and the nuclear layers were greatly reduced in thickness. Similar observations have been made by Vogel (personal communication). These observations show that the sensitivity of the retina and especially the rods and cones layers in the retina is a phenomenon not restricted to amphibia.

In general, if we compare the sensitivity

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with 8,000 r and 55 days after hatching. Large macrophages (M) in connective tissue of treated region of head. Photomicrograph ×500. (*E*) Frontal section through the head of animal 83 days after irradiation with 4,000 r and 97 days after hatching (treatment 14 days after hatching). A macrophage near the eye. Photomicrograph ×106. E, epithelium; M, macrophage; P, pigment layer of choroid; R, retina. (*F*) The same section as that in (*E*). CT, connective tissue cell (fibroblast); EC, eye cartilage; M, macrophage near eye cartilage. Photomicrograph ×500.

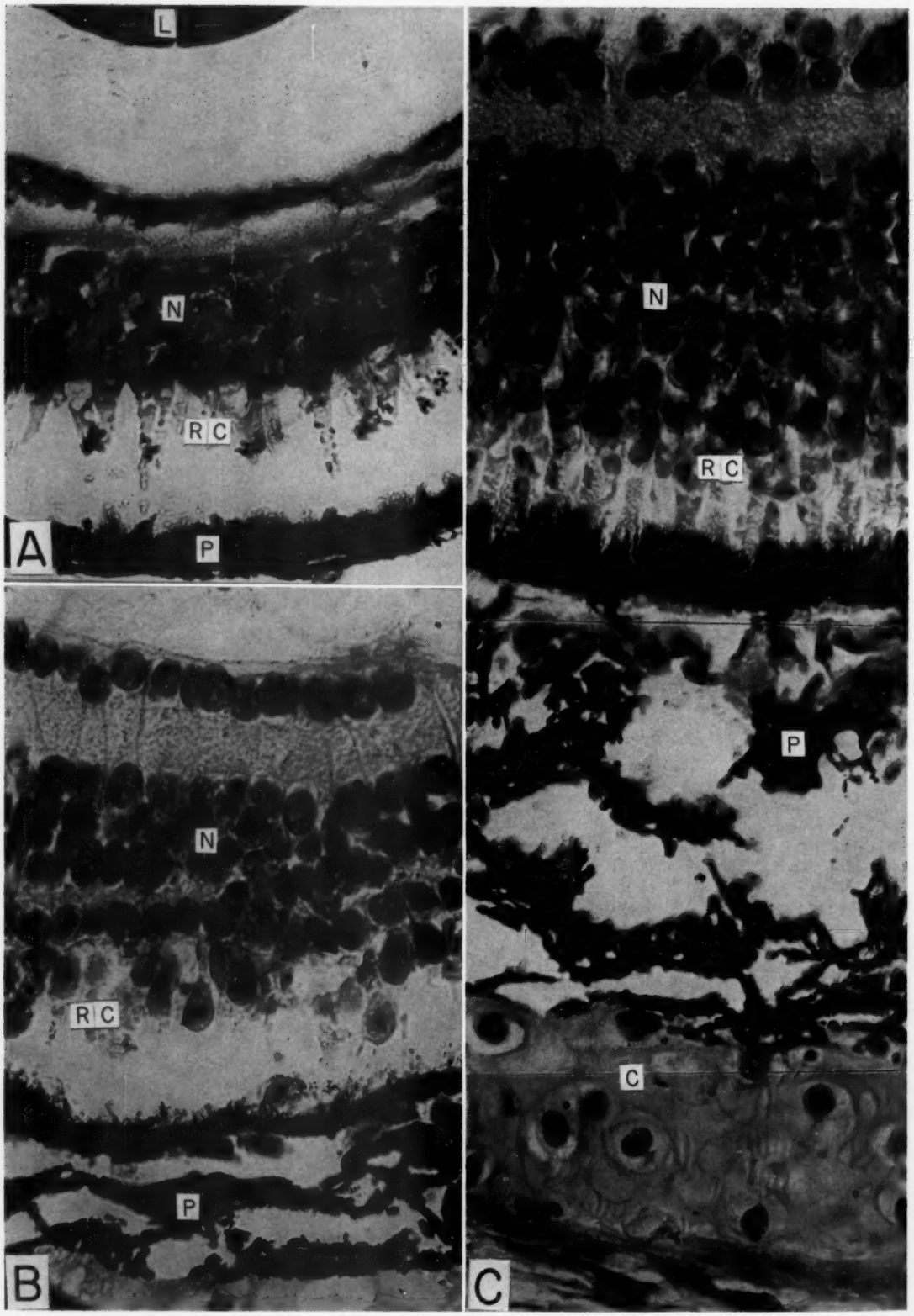

FIG. 6

to roentgen rays of amphibia, on the one hand, and mammals and men, on the other, it is clear that, in any case, the radiation sensitivity of warm-blooded animals will be less than the sensitivity of cold-blooded animals, and adults far less sensitive than young individuals. According to Cogan,[14] the eyes of men irradiated with large doses (4,000 to 6,000 r) for treatment of nasopharyngeal tumor showed lesions in the cornea of the eye. He did not observe any pronounced damage in the layers of the retina of adults.

It would be interesting to study the ocular defects in patients of various ages who receive similar radiation treatments involving the eyes. There is the possibility that the cause of some cases of failure of vision would be discovered. Such defective vision would be more likely in children receiving relatively large doses to the eyes. In the case of the human embryo, even small doses may cause subtle undetected changes in the retina which would become evident years later in the form of a visual defect. This would suggest careful study of human subjects who have received radiation during intrauterine development to look for possible radiation-induced visual defects. For this and other reasons, it is necessary to agree with Russell and Russell[40] that even the small doses which pregnant women receive during diagnostic roentgenoscopy may cause subtle developmental alterations which in human being would be important (see also Hicks,[23] Job, Leibold and Fitzmaurice,[27] Wilson, Jordan and Brent[48]).

In spite of more than fifty years of practical use of roentgen rays in medicine, our knowledge of the biolcgical effects of irradiation is limited, and therefore further investigations in this field are necessary and important.

SUMMARY

Most of the seventy-five axolotls used in this investigation were irradiated locally with 4,000 to 5,000 roentgens at the age of nine to seventeen days after hatching.

In the irradiated eyes there was observed, not only an arrest of the development and growth, but the cells of the cornea and retina were comparatively large. Probably this phenomenon is similar to the process of the formation of giant degenerating cells which is typical for irradiation damage in general. At the same time, however, the most radiation sensitive cells had been killed and had disappeared completely.

The great resistance of the pigment cells of choroid was obvious and was observed in all cases. These cells were concentrated at the center of the eye because of the simultaneous degeneration of other components. Therefore, the rudiments of some of the eyes consisted only of pigment cells. Such rudiments never disappeared entirely.

The cells of the retina are the most sensitive to irradiation. In some eyes only slightly damaged by irradiation, the rods and cones layer was greatly reduced. After irradiation with larger doses, it was obvious that there was almost a complete absence of the rods and cones layer. This layer is the most sensitive part of the retina to roentgen irradiation.

This great sensitivity of the retina to irradiation is not limited to amphibia. This is evident both from the papers of Lorenz and Dunn[30] and from our own observations

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Fig. 6. The structure of a normal retina in animals of various ages and of an irradiated retina in an experimental animal. (*A*) Structure of the retina of normal animal 9 days after hatching. Photomicrograph ×500. (*B*) Structure of the retina of an animal 55 days after irradiation with 4,000 r (fixed 70 days after hatching). The rods and cones layer greatly reduced. Photomicrograph ×500. (*C*) Structure of the retina of a normal animal 220 days after hatching. Photomicrograph ×500.

C, eye cartilage; L, lens; N, nuclear layers of the retina; P, pigment cells of choroid; RC, rods and cones layer of the retina.

on the radiation sensitivity of the retina of young mice (Brunst and Figge[12]) in which the rods and cones layer likewise exhibited the greatest sensitivity.

This hypersensitivity of the rods and cones layer to roentgen irradiation was thus found in both warm-blooded and cold-blooded animals. The practical significance of these observations as they may apply to the human subject has been discussed.

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PARTIAL BODY IRRADIATION OF THE RAT WITH 190 MEV. DEUTERONS*†

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A COLLIMATED high energy deuteron beam will traverse the width of a rat and provide essentially uniform dosage along its path through the animal. Lateral scatter from the beam is negligible;[9] hence small cylindrical volumes of tissue can be irradiated uniformly with virtually no background dose given to the surrounding structures. In the experiments reported here, the effects of single doses of such radiation delivered to various anatomical regions of the rat were investigated.

EXPERIMENTAL PROCEDURE

High energy (190 mev.) deuterons from the 184 inch cyclotron located on the Berkeley Campus of the University of California were focused into a parallel beam and allowed to enter an irradiation room through a small circular aperture (Fig. 1). The beam traversed the desired portion of the immobilized animal, placed approximately 25 inches beyond the aperture. Physical characteristics of the beam, and calibration data, have been presented in detail previously.[9] Beams of $\frac{5}{8}$ or $\frac{3}{4}$ inch diameter were used. Doses are expressed in rep units (1 rep = 93 ergs/gram). The doses referred to in this paper correspond to the specific energy transfer[9] and are average dose values for the center portion of the beam. The rate of energy loss of the deuterons was approximately 7.5 mev/g/cm.^{2} at the point of entry and about 8.5 mev/g/cm.^{2} at the point of exit from the animal body. Dose rates varied from 1,000 to 3,000 rep/min. The degree of scatter of the beam is indicated by the doubly exposed roentgen film shown in Figure 2. A lateral roentgenogram of a rat was taken, followed by lateral exposure to the deuteron beam with the relative positions of animal and film unchanged. The circular white area, about $\frac{3}{4}$ inch in diameter, represents the effective diameter of the $\frac{5}{8}$ inch beam after traversing the body of the rat. The increase in width is due to multiple elastic scattering. Clearness of the appearance elsewhere (beam exposure of about 200 rep) indicates the low degree of scattered radiation in the remainder of the rat. Radiation which scattered outside the beam was composed chiefly of fast neutrons and amounted to only 0.5 per cent of the dosage within the beam.

The biological effectiveness of 190 mev. deuterons relative to roentgen rays was reported previously to be unity.[9] This value was confirmed in the course of the present experiments, using acute mortality following total body roentgen irradiation of C57 mice as the criterion.

Approximately 600 young adult male Sprague-Dawley rats were used in these experiments. An effort was made to obtain rats of uniform size for a given experiment; in some instances, however, weights varied over a maximum range of 75 grams. Rats that weighed less than 220 grams were not used. In the majority of experiments, animals were deprived of food approximately twenty-four hours prior to exposure.

For irradiation, each animal was restrained with masking tape in the supine position on a plywood board the length and width of the rat. No anesthesia was employed. Target sites were located with reference to the easily palpable xiphoid cartilage. The centers of the various target sites were determined from this point of reference and marked on the tape covering the animal. Designation and location of the centers of these sites with respect to the lower border

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† The opinions and assertions contained in this report are the private ones of the writers and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large. (Article 1252, U. S. Navy Regulations, 1948.)

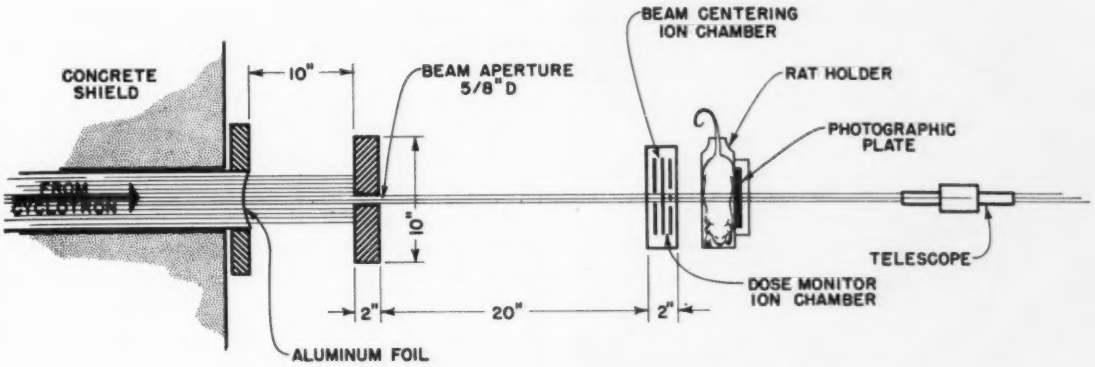

FIG. 1. Experimental set-up for deuteron irradiation of the rat.

of the xiphoid cartilage are indicated in Table I.

In order to determine the amounts of tissues exposed in the beam, rats immobilized as if for irradiation were "quick frozen" by immersion in an acetone-dry ice mixture. Cylindrical volumes of tissue corresponding to the various irradiation sites were then excised and weighed (Table I). Each value given is the mean of those of at least 10 animals that were fasted for twenty-four hours before sacrifice. Considerable variation in the amounts of total and gastrointestinal tissue in the sites is indicated by the large standard errors obtained. The total weight of gastrointestinal tissue in rats of the size used

TABLE I

BODY REGIONS SUBJECTED TO DEUTERON IRRADIATION

Designation of Region	Type of Exposure	Location with Respect to Lower Border of Xiphoid Cartilage	Total Weight of Tissue in Beam		Weight of Gastrointestinal Tissue in Beam[a]	
			Grams	Per cent body weight	Grams	Per cent body weight
Upper abdomen	Lateral	1 cm. caudad	10.6 0.3[b]	4.4	1.3 0.1[b]	0.54
Middle abdomen	Lateral	2 cm. caudad	10.2 0.1	4.4	2.1 0.1	0.92
Lower abdomen	Lateral	3 cm. caudad	9.8 0.2	4.2	1.7 0.1	0.70
Stomach	Antero-posterior	0.5 cm. caudad; 1 cm. to left	4.9 0.3	2.1	0.4 0.1	0.15
Duodenum	Antero-posterior	1 cm. caudad; 0.5 cm. to right	5.6 0.2	2.4	0.1 0.1	0.05
Adrenals	Lateral	See text	10.6 1.4	4.4	0.2 0.2	0.08
Chest	Lateral	4 cm. cephalad	9.6 1.3	3.9	0	0

[a] Exclusive of gut contents.
[b] Standard error of the mean.

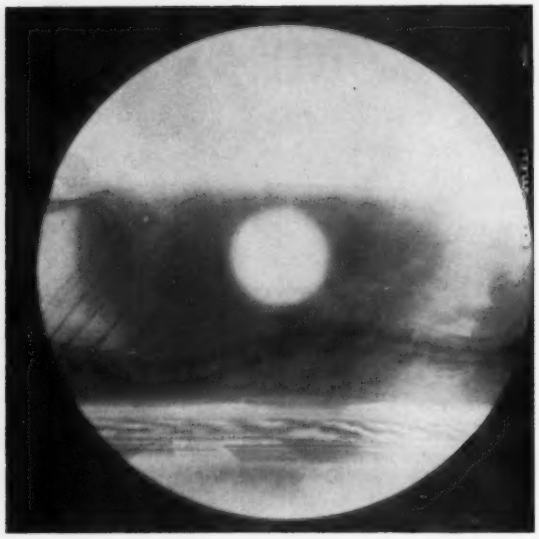

FIG. 2. Roentgenogram of mid portion of rat in position for lateral irradiation with the deuteron beam. Circular white spot indicates the path of the beam.

in these experiments is approximately 9 grams. "Adrenal" exposures were made by allowing the beam to enter the animal's left side, with the target center 2.6 cm. caudad to the xiphoid cartilage and 0.5 cm. anterior to the restraining board, and to pass obliquely through the rat at an angle of 65° with its long axis. Frozen section data indicated that both adrenals were included in the region thus described in over 75 per cent of the animals.

A single animal was irradiated at a time. Doses used are indicated in Table II. The time of exposure varied from approximately one to four minutes. Animals were transported by car from the U. S. Naval Radiological Defense Laboratory (USNRDL) to the cyclotron (20 miles) on the day of irradiation, and were returned to the Laboratory on the same day. Rats were weighed at frequent intervals and observed for signs of illness and mortality for at least thirty days. Gross pathological changes were noted at necropsy in animals dying within thirty days, and in several groups of survivors sacrificed at intervals up to 240 days post-irradiation. Microscopic pathology was not included in the present study. The pathology of late bowel lesions observed in deuteron irradiated rats has been reported previously.[2]

TABLE II

SUMMARY OF EXPERIMENTS

Site Irradiated	Experiment Number	Beam Diameter (in.)	Dose or Dose Range (rep)	Number of Doses	Number of Rats per Dose	Mean Body Weight (gm.)	Mortality (30 days)
Upper abdomen	5	½	1,836–2,484	2	10	385	No deaths
	6	½	1,620–3,240	5	7	232	72 per cent or greater in all dose groups[a]
	8	½	864–2,052	6	5	224	Approx. LD_{50}, 1,500 rep
Middle abdomen	2	¼	2,160–2,810	4	7	343	14 to 68 per cent[a]
	3	¼	1,404–3,024	8	7	241	Approx. LD_{50}, 2,000 rep
	6	½	1,620–3,240	5	7	234	100 per cent all groups
	8	½	864–2,052	6	5	226	60 per cent or greater in all dose groups[a]
Lower abdomen	1	¼	648–2,050	6	5	285	No deaths
	2	¼	2,160–3,460	7	7	338	No deaths
	3	¼	3,240–4,320	5	7	239	Approx. LD_{50}, 3,500 rep
	6	½	1,620–3,240	5	7	233	100 per cent all groups
	8	½	864–2,052	6	5	225	Approx. LD_{50}, 1,350 rep
Stomach	4	½	1,836–3,130	5	10	285	No deaths
	5	½	3,132	1	10	365	No deaths
Duodenum	5	½	1,512–3,132	6	10	359	No deaths
Adrenals	5	½	1,944–3,564	4	3 to 6	341	No deaths
	9	½	3,500	1	30	—	No deaths
Chest	2	¼	3,020–5,076	5	7	289	One death (4,536 rep)

[a] Data insufficient to calculate LD_{50}.

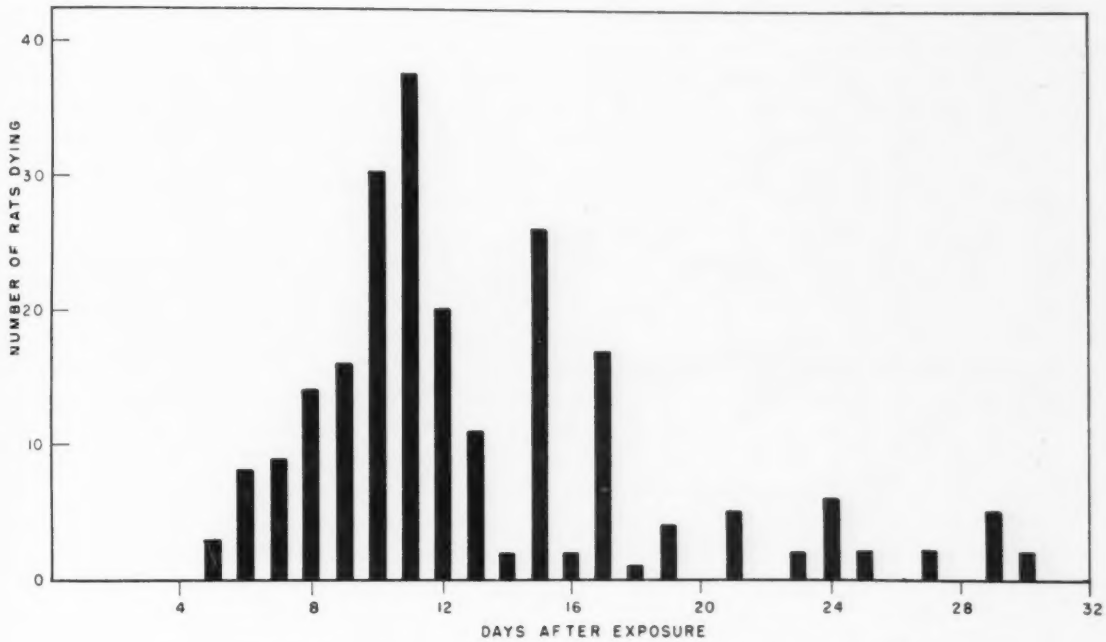

Fig. 3. Distribution of acute deaths among rats receiving deuteron irradiation laterally to small portions of the abdomen.

RESULTS

Mortality. Acute radiation mortality (within 30 days) was confined essentially to those groups irradiated laterally through the abdomen. The data are presented in Table II. No deaths occurred within this period in groups irradiated anteroposteriorly in the stomach or duodenal regions (doses up to 3,132 rep). Of the 35 animals receiving radiation laterally to the chest at dose levels up to 5,076 rep, only 1 died within thirty days.

Although considerable acute mortality occurred among animals irradiated laterally through the abdomen, there appeared to be little correlation between dose and mortality in these groups. Deaths occurred in some experiments at doses as low as 864 rep, while in others some rats survived doses as high as 3,240 rep. An accurate estimate of LD_{50} values could not be made, nor was it possible to demonstrate consistent differences in mortality resulting from lateral irradiation of the upper, middle and lower abdomen. An approximate LD_{50} of 2,000 rep was obtained by combining all mortality data for lateral abdominal irradiation.

Sporadic deaths beyond thirty days occurred in all groups that received radiation anteroposteriorly, as well as laterally, to the abdomen. Although approximately 15 to 20 per cent of all animals so exposed in this investigation died between the thirtieth and sixtieth day, the data do not permit a reliable estimate of the death rate beyond the acute period. Therefore, these data have been omitted.

Survival Time (Acute Period). No correlation was apparent between mean survival time and either site irradiated or dose. The general pattern of survival time of animals dying acutely is shown in Figure 3, in which data from all groups that received radiation laterally to the upper, middle and lower abdomen have been combined. Mean survival time was approximately thirteen days.

Symptomatology. Acute illness (within 30 days) was confined for the most part to those rats irradiated laterally through the upper, middle or lower abdomen. All such

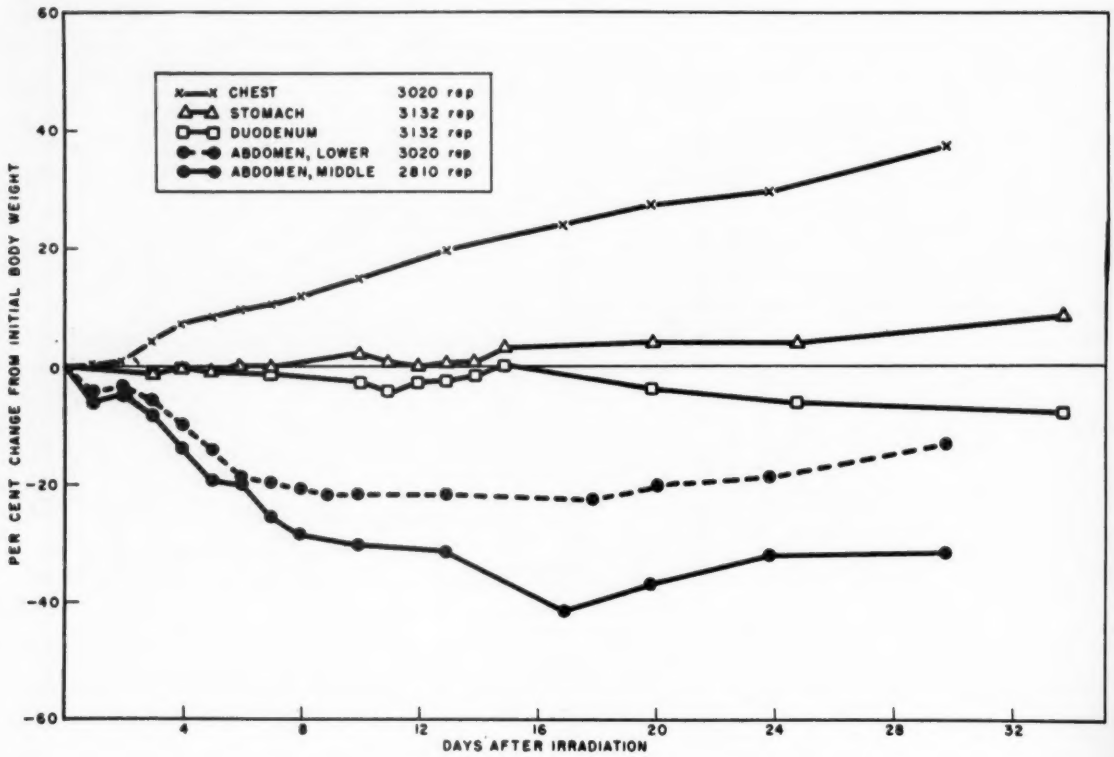

FIG. 4. Body weight changes in deuteron irradiated rats.

animals presented essentially the same clinical picture, characterized by progressive weight loss, ruffled fur, diarrhea (frequently bloody) and, not infrequently, secretions from the eyes and nose. Diarrhea appeared toward the end of the first week and persisted for several days. Severity of illness, like mortality and survival time, was not well correlated with dose. Rats that died earlier (5th to 7th day) usually showed a less severe loss of weight (5 to 15 per cent) at death than those that died later in the first month (20 to 40 per cent). Beginning of weight gain among survivors coincided with the cessation of diarrhea during the second and third week.

Rats irradiated anteroposteriorly through the stomach or duodenum did not appear ill, with the exception of mild short-lived diarrhea during the second week in less than 10 per cent of those exposed. Weight gain was impaired, more so in duodenum than in stomach irradiated animals. Chest and adrenal irradiated rats showed little or no impairment of weight gain and no gross symptoms. Body weight changes relative to the site irradiated are indicated by the representative weight curves shown in Figure 4.

Circular areas of depilation at the point of entrance and exit of the deuteron beam were found conistently at the higher dose levels, and were clearly evident by the twelfth day after doses of 1,836 rep and above in some animals. The exact threshold dose for this effect was not determined.

Signs of illness which developed after the first month were referable to the bowel, spinal cord and skin. Deaths occurring later than thirty days usually were not preceded by marked weight loss or reappearance of diarrhea. Those animals that received radiation to the spinal cord (adrenal and anteroposterior abdominal exposures) gave evidence of cord damage beginning about two months after exposure. Paralysis of the hind limbs of all animals so irradiated was complete by three months after exposure.

Among animals receiving radiation to the bowel, nodular easily movable masses were palpable in the abdomen as early as six weeks following irradiation. As many as three such masses could be detected in a single rat. Depilated areas often became chronically ulcerated, the lesions persisting throughout the period of observation (7 months postirradiation). In healed areas the skin was contracted, thin, and glistening in appearance. No regrowth of hair was noted.

Necropsy Findings. Necropsies during the thirty day observation period were performed only on animals that died spontaneously, and hence were limited to the lateral abdomen exposure groups. Pathologic findings in all three groups thus irradiated were similar, and were confined essentially to the abdominal region. Over 30 per cent of the animals showed either ascites (nonhemorrhagic), peritoneal exudate, visceral adhesions or combinations of the three. The spleen was characteristically small, and lymph nodes were frequently enlarged, particularly in the cecal region. Apparent adrenal hypertrophy was noted in a few animals. The stomach was greatly distended with fluid, and the lower intestinal tract was usually dilated and contained dark material.

Most striking were the lesions observed in the intestine, and in the stomach, although less frequently. The intestinal lesions were usually annular, discrete, and markedly hyperemic, involving sections of intestine from 5 to 20 mm. in length. It was common to observe three or four such discrete lesions over a 10 to 12 cm. length of intestine, with normal intestine intervening. The visibly affected bowel represented only a small percentage of the total exposed in the beam.

The affected areas seen when the bowel was opened were thin and denuded of epithelium. Grossly apparent blood was usually present in the lumen. Frank perforation of the bowel was not observed. The fluid present in the stomach was rarely hemorrhagic. Although petechiae were seen occasionally in the stomach in areas believed not to have been irradiated, gross hemorrhage outside of the irradiated area was not observed. The hemorrhagic diathesis seen following total body irradiation was not observed in these animals.

Animals that died beyond the first month presented a different picture. The ulcerated segments of intestine had enlarged to form hard, annular, tumor-like masses, 1 to 3 cm. in diameter. Often several such masses, of varying sizes, were found in a single animal. The bowel wall at the site of the lesion was thickened and fibrous, and the internal surface of the lesions was covered with a necrotic and foul smelling membrane-like structure. Firm fibrous adhesions bound neighboring viscera to these masses. Frequently the bowel was obstructed by one of the lesions and was greatly distended proximal to the stenosis. The obstruction was presumably the cause of death in these cases.

Some survivors from each of the various exposure groups were sacrificed at times varying from 93 to 240 days after exposure. Those irradiated laterally through the chest showed a very high incidence of pulmonary fibrosis in the path of the beam. The heart appeared normal. Pleural and pericardial adhesions were a frequent finding. A number of small white, apparently calcified, areas were noted in the thoracic wall in the path of the beam. Pleural fluid was occasionally present.

The tumor-like masses in the intestine were observed in all groups that received radiation to the abdomen. With lateral irradiation, 17 of 26 animals sacrificed evidenced the lesion. With anteroposterior irradiation, the lesion was present in 10 of 60 animals sacrificed (4 of these lesions were in the stomach, and all of these occurred in the stomach irradiated group). Usually a single lesion per animal was seen in the anteroposteriorly irradiated rats; two or more in those irradiated laterally. In general, the older lesions were larger in size.

Grossly apparent atrophy of a kidney was observed occasionally. Particularly

striking was the sharp line of demarcation between normal and atrophic portions of the kidney found in 2 rats, resulting presumably when only a portion of the organ was included in the irradiation field. The adrenals were grossly normal, and no changes in the liver ascribable to irradiation were noted.

DISCUSSION

The lethal syndrome seen in these experiments following highly localized deuteron irradiation of small portions of the bowel was distinctly different from that usually associated with exposure of the gastrointestinal tract. If any large portion or all of the bowel (mouse or rat) is roentgen irradiated at doses sufficient to kill, the animal dies with a symptom complex indistinguishable from that seen following total body irradiation in the high lethal or supralethal dose range.[1,5,6,7] Mortality resulting from such irradiation has been attributed to wide spread destruction of the bowel mucosa, which causes a shock-like "radiation toxemia,"[6] and culminates in early death. Mean survival time is remarkably constant at four or five days.[1,6] Peritonitis and hemorrhage are notably absent.

Following irradiation of very small volumes of intestine, however, the "radiation toxemia" and four to five day survival time noted above were not seen even at extremely high doses. Survival time of acute nonsurvivors varied considerably about a mean of twelve or thirteen days, and death resulted apparently from local or generalized peritonitis, from hemorrhage into the bowel or from bacteremia secondary to focal bowel necrosis. Mucosal destruction, while complete in affected areas, apparently was not sufficiently extensive to produce a fatal toxemia. The injury produced can be compared to that from a bullet piercing the bowel, and it seems likely that immediate prognosis following such irradiation depends on the exact anatomical location of the lesion with respect to ease of walling off and combating necrosis, infection and, possibly, perforation. The strains of bacteria extant probably are a major factor in prognosis. Ultimate prognosis is affected also by the progressively stenosing character of the lesions. The relative "sensitivities" of different animals or of different regions of the bowel in a single animal, as indicated by the mortality response following this type of irradiation, probably depend not on differences in tissue radiosensitivity *per se* among the bowel regions exposed, but on the ability of the animal to combat the sequelae of localized bowel necrosis.

As has been pointed out, the gastrointestinal lesions observed at necropsy involved only a small portion of the total intestinal tissue exposed in the beam. Possible marked shortening of affected loops, previously noted[4] in dogs sacrificed several weeks after localized roentgen irradiation, does not appear to be the explanation here. In a serial sacrifice experiment (unpublished), the earliest lesions noted were similarly small, discrete and affected only small portions of the total bowel exposed.

The absence of definite hemorrhage outside of the localized irradiation field confirms previous work on guinea pigs.[3] Hemorrhage within the field was associated invariably with ulceration. It is not known if the delayed damage to the spinal cord when that organ was included in the beam resulted from direct damage to the nervous tissue or from degeneration secondary to vascular damage.

The question of the relationships of mass and type of tissue exposed to mortality and the lethal dose arises. Regardless of the body region exposed in these studies, the lethal dose for irradiation confined to small masses of tissue was high compared to that for total body irradiation. With respect to the abdomen, the lethal dose for small volume irradiation exceeded that for irradiation of the entire abdomen,[1] and no particularly sensitive portion was discernible within this region by the irradiation procedures and in the dose ranges used. Deaths within thirty days of irradiation were produced only if portions of the intestine were included in the field. Thus, lat-

eral abdominal irradiation was frequently 100 per cent lethal at doses as low as 1,500 rep, while adrenal or chest irradiation, in which essentially the same weight of tissue was exposed, did not result in acute deaths or any marked signs of illness. The previously noted radiosensitivity of the abdomen (mortality is used as the criterion of sensitivity) is borne out with highly localized irradiation, indicating clearly that lethality following partial body irradiation is related primarily to the relative radiosensitivity of the tissue irradiated and to its importance in the total economy of the animal, and only secondarily to the weight of tissue irradiated.

No acute mortality resulted from anteroposterior irradiation of the abdomen, in which the weight of bowel exposed was roughly one-fifth of the amount exposed in lateral irradiation. Additional unreported deuteron experiments designed specifically to vary the proportion of gastrointestinal tissue in the beam (by fasting the animal prior to exposure or changing of the beam diameter), while not conclusive in themselves, tended to support the view that an inverse relationship exists between amount of bowel exposed and lethal dose. This is in agreement with other studies,[8] in which the LD_{50} for roentgen irradiation of various large portions of the abdomen was inversely correlated with the amount of bowel exposed and not with the total weight of tissue irradiated.

These findings suggest that the lethal dose may be a function of the total energy absorbed by the bowel (grams of gastrointestinal tissue exposed multiplied by roentgen radiation dose). Such a relationship appears likely on theoretical grounds in the case of lethal irradiation of large portions of bowel, where all exposed intestinal tissue seems to be affected uniformly, and death appears due to toxemia secondary to massive mucosal degeneration. Increasing either dose or amount of bowel exposed would theoretically provide more degenerating mucosa, thus increasing morbidity and mortality. Experimental results support this contention.[1,6,7,8] However, in the case of irradiation of relatively small portions of bowel, the present investigation has revealed an entirely different syndrome. As described above, and also noted by others,[10] not all of the bowel exposed in the beam is affected grossly, and the number and size of lesions are highly variable among animals given presumably identical irradiation. Thus, the degree of injury in this case does not appear to bear a quantitative relationship to the total energy absorbed by the intestine. It is probable, then, that the poor correlation of morbidity and mortality with dose administered is due to part in this fact, and in part to the several factors previously mentioned which affect the subsequent pathogenesis and recovery of lesions in the affected tissues.

SUMMARY

1. Irradiation of various small portions of the rat with a high energy (190 mev.) deuteron beam $\frac{5}{8}$ or $\frac{3}{4}$ inch in diameter resulted in negligible acute mortality except after lateral exposures of the abdomen.

2. Mortality was poorly correlated with dose over the range employed (864 to 5,076 rep). No correlation was apparent between mortality and lateral abdominal site irradiated, nor between mean survival time and either site irradiated or dose.

3. Destruction of the bowel mucosa with this type of irradiation apparently was not sufficiently extensive to cause the acutely fatal syndrome seen within four or five days of irradiation of the whole, or a large portion of, the abdomen. Instead, deaths apparently resulted from peritonitis, hemorrhage into the bowel or from bacteremia secondary to focal bowel necrosis. Several factors affecting ultimate prognosis are discussed.

4. Chronic ulcerative bowel lesions of a progressively stenosing character were observed three to seven months after abdominal irradiation.

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ABSORPTION OF PLUTONIUM FED CHRONICALLY TO RATS

I. FRACTION DEPOSITED IN SKELETON AND SOFT TISSUES FOLLOWING ORAL ADMINISTRATION OF SOLUTIONS OF VERY LOW MASS CONCENTRATION*

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THE principal objective of this study was to measure the fraction of plutonium administered orally to rats which is absorbed from the gastrointestinal tract and is subsequently deposited in the skeleton and soft tissues. A survey of the literature pertaining to the metabolism of plutonium revealed that previous studies had involved the feeding of relatively high concentrations of plutonium to small numbers of animals during short periods of time.[4] The calculation of the currently accepted maximum permissible concentration (M.P.C.) for the soluble compounds of Pu^{239} in drinking water (1.5×10^{-6} μc./ml.)[6] was based on gastrointestinal absorption values obtained under conditions rather far removed from those apt to be encountered as a result of chronic contamination of food or water. The present study involved the feeding of plutonium solutions approximating the M.P.C. to 160 rats over a period constituting a significant fraction of the life span of the animal.

EXPERIMENTAL PROCEDURE

One hundred and sixty young adult Sprague-Dawley rats were divided into 4 groups of 40 experimental rats each (20 males and 20 females). These animals were housed in individual cages having ½ inch mesh wire floors which allowed excreta to drop through to prevent coprophagy. Dog chow pellets (Purina) and water were supplied *ad libitum*. In order to permit deposition of detectable amounts of plutonium in the bones and soft tissues in spite of the low mass levels of radioelement in the feeding solutions and in spite of the low percentage absorption of plutonium from the gastrointestinal tract, Pu^{238} was used for all feedings.† By virtue of the high specific activity of Pu^{238} (about 260 times greater than that of Pu^{239}) solutions of low mass concentration could be employed.

Details of the feeding regimen are summarized in Table 1. It was originally planned to administer only one dose of plutonium per day to each rat, but in order to shorten the duration of the experiment, feedings were increased first to two doses per day, then to three, and for the last month of feedings to four doses per day. Doses administered to a given rat were always separated by at least two hours.

In order to maintain control over possible sources of contamination during feedings as well as during radiochemical analyses, 40 additional rats (20 males and 20 females) were subjected to the same procedures as the experimental animals, except that plutonium was omitted from the solutions administered. The gavage apparatus used in the feedings is diagrammed in Figure 1. Separate gavage units were employed for feeding the control rats and each group of experimental animals. Adsorption of plutonium on rubber and glass was minimized by coating syringes, pipettes, catheters, and flasks with a silicone preparation (dimethyldichlorosilane, General Electric Co.).

As a control on the actual amount of plutonium administered to each group of experimental rats, 1 milliliter volumes of each feeding solution were delivered, before and after each feeding of a given rat group, directly from the gavage unit onto counting plates. Data listed in Table 1 for the amount of plutonium fed to each group were derived from statistical analyses of the counts obtained from these plates. The plus-or-minus figures represent 95 per cent confidence limits.

Upon completion of the feedings, 30 rats in

† The Pu^{238} was obtained from Dr. G. T. Seaborg, University of California Radiation Laboratory, Berkeley, California.

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TABLE I

DOSAGE SCHEDULE
(Each group represents 40 rats)

Group	Pu^{238} per Average Dose		Fraction of M. P. C. (weight basis)*	Total Amount of Pu^{238} Fed	
	d./m.	μμg.		d./m.	μμg.
I	36	1	0.04	18,821 ± 210	523
II	110	3	0.12	56,698 ± 770	1,575
III	365	10	0.40	188,707 ± 752	5,242
IV	1,121	31	1.2	579,878 ± 2,256	16,108

Chemical form of administered Pu:	$Pu(NO_3)_4$
pH of administered solution:	2.0
Mode of administration:	stomach tube
Volume administered per dose:	1.0 ml.
Frequency of administration:	1–4 doses per day, 5 days per week
Duration of experimental feeding period:	$9\frac{1}{2}$ months
Total doses administered:	517

* Since the specific activity of Pu^{238} is about 260 times greater than that of Pu^{239}, a mass concentration of Pu^{238} equal to the M.P.C. for Pu^{239} (1.5×10^{-6} μc./ml., or 3.4 d./m./ml.) would have an activity of about 900 d./m. The Pu^{238} employed was chemically and radiochemically pure. A slight isotopic impurity of Pu^{239}, below radiochemically detectable limits, may have been present. Such impurities may have increased the weights fed over those listed above by an amount not exceeding 25 per cent.

the group receiving the solution containing the highest plutonium concentration were set aside for biological turnover studies, as will be described later. The remaining experimental rats and all control rats were sacrificed by etherization, after being fasted for four days to clear the gastrointestinal tract of adsorbed plutonium. Each animal was skinned and the entire gastrointestinal tract carefully removed, after clamping off esophagus and anus. The remainder of the carcass was eviscerated and autoclaved for thirty minutes at 15 pounds pressure in order to soften the muscle and facilitate separation of bones. The de-boned carcass was recombined with the viscera to constitute the soft tissue sample.

In order to ascertain whether plutonium was leached from the bone during the autoclaving process, a preliminary control experiment was performed. Ten Sprague-Dawley rats were injected intraperitoneally with 3.2×10^4 d./m. of Pu^{239} (IV) as the citrate. Seventy-two hours later these animals were sacrificed and their limbs removed. After carefully scraping away the muscle, the bones of one forelimb and hindlimb of each animal were analyzed for plutonium. The bones of the forelimb and hindlimb from the opposite side of the body of each animal were autoclaved for thirty minutes at 15 pounds pressure before being analyzed for plutonium. Results of analyses are summarized in Table II. It is apparent that the plutonium content of autoclaved and non-autoclaved bone samples is not significantly different. This was confirmed by carefully rinsing with hot nitric acid the beakers in which bones had been autoclaved and evaporating the washings on counting plates. In every case activity found was negligible.

In view of the extended duration of the feed-period, it was necessary to obtain knowledge of the biological turnover of deposited plutonium. Ten of the 40 rats receiving the highest plutonium concentration (designated as Group IVa) were sacrificed at the same time as the other experimental rats. The remaining 30 rats in Group IV were divided into 3 subgroups of 10 rats each (designated as Groups IVb, IVc, and IVd) and these groups were sacrificed 90, 180 and 250 days after feedings had been discontinued.

The various tissue segments, bone, soft tissue, pelt and gastrointestinal tract were digested with concentrated nitric acid, evaporated to dryness, and muffled to a white ash at 600° C. The ash was dissolved in 2 *N* nitric acid and analyzed according to a standard procedure for biological samples of low activity density now in use in our laboratory.[2]

Tissues from experimental rats were analyzed simultaneously with similar tissues from rats in the control group and with a tissue to which

a known amount of plutonium was added. Results on experimental tissues were corrected for the activity found in the control tissues and for the per cent recovery obtained from the spiked tissue. In order to minimize the possibilities of cross contamination, all tissue segments from rats in a lower plutonium feeding level were analyzed before commencing analyses on tissues from the next higher level.

Samples were counted on proportional low background alpha counters (manufactured by the Nuclear Instruments Corp.) having a 52 per cent geometry and operating at the 95 per cent confidence level. Background was less than 0.5 counts per minute.

RESULTS

A mortality of about 5 per cent occurred over the entire feeding period of nine and one-half months. Deaths usually could be attributed to respiratory ailments. The average plutonium contents in the body fractions of the experimental rats are given in Table III. These values have been corrected for the activity detected in the simultaneously analyzed control rats as well as by appropriate factors based on average spike recovery data obtained for each group and for each type of tissue. Values shown in parenthesis were not statistically different at the 95 per cent confidence level from values obtained on similar tissues from control animals.

In the case of animals on the lowest plutonium feeding level (Group I) only the gastrointestinal tract showed significant plutonium retention, while the rats in Group II which received solutions of 0.12 of the M.P.C. showed significant retention in all body fractions except the soft tissues. The skeleton and soft tissues of the animals which received solutions of 0.4 of the M.P.C. and 1.2 times the M.P.C. were found to contain significant amounts of plutonium. The same was true of the gas-

TABLE II

COMPARISON OF TOTAL AMOUNTS OF PLUTONIUM FOUND IN FRESH AND AUTOCLAVED BONE
(d./m. $\times 10^{-3}$)

Rat No.	Fresh Bone Sample	Autoclaved Bone Sample
1	2.64	2.69
2	3.09	2.76
3	2.39	2.16
4	2.82	2.76
5	3.22	3.01
6	2.96	3.14
7	3.16	2.76
8	2.76	2.69
9	3.11	2.81
10	2.36	2.54
Total	28.51	27.32

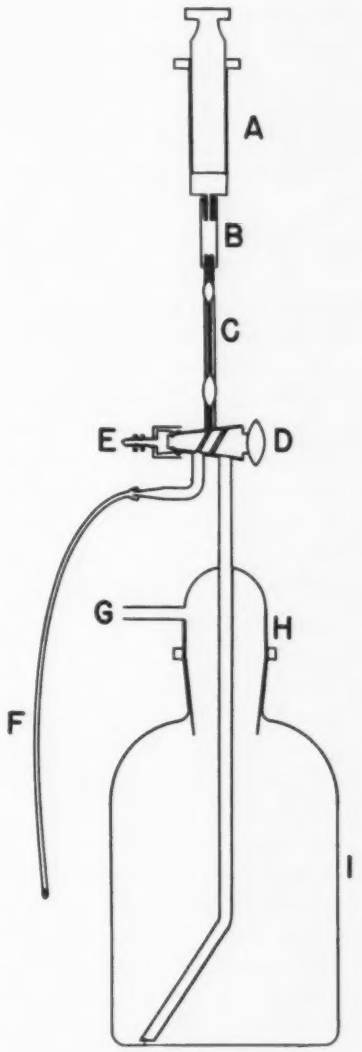

FIG. 1. Gavage apparatus used for feeding plutonium to rats. *A*—3 ml. syringe. *B*—Rubber sleeve. *C*—1 ml. pipette. *D*—3-way stopcock. *E*—Stopcock adapter. *F*—Rubber catheter (French No. 8). *G*—Air vent. *H*—Ground glass connection. *I*—Plutonium solution flask.

TABLE III

AVERAGE PLUTONIUM DEPOSITION IN BODY FRACTIONS
(d./m. ± 95 per cent Confidence Limits)

(Values in parenthesis are not significantly different from controls)

Group	Gastrointestinal Tract	Pelt	Skeleton	Soft Tissue
I	2.94± 0.55	(0.09±0.36)	(0±0.36)	(0.50±0.52)
II	4.65± 1.36	0.21±0.17	1.10±0.29	(0.04±0.18)
III	14.80± 5.05	0.69±0.33	4.64±0.59	0.84±0.76
IVa	104.48±80.96	2.88±2.20	14.68±3.79	1.28±0.93
IVb	(0.14± 0.75)	(0.87±0.87)	13.57±2.59	1.16±0.76
IVc	10.42± 6.63	(0±0.53)	12.10±1.65	4.62±2.53
IVd	(0.82± 1.44)	(0.23±1.82)	13.03±2.48	2.88±2.37

trointestinal tracts and pelts of the rats in these last two groups which were sacrificed immediately after cessation of plutonium feedings. The plutonium content in the pelts and gastrointestinal tracts of the rats on the highest level of plutonium administration (Group IV) which were sacrificed at various time intervals following cessation of feedings showed a decreasing contamination with time and reached non-significant levels at the end of ninety days.

Table IV shows the per cent of fed plutonium which was absorbed from the gastrointestinal tract and deposited in the skeleton and soft tissues of the experimental rats. In calculating the total per cent absorbed, the amounts of plutonium found in the pelts and gastrointestinal tracts were neglected, since, as indicated by the sharp drop in activity following cessation of feedings, the former values represent largely contamination of pelt by excreta, while the latter consist of physically adsorbed plutonium on food particles or gastrointestinal mucosa which were not removed during the four day pre-sacrifice fasting period.

DISCUSSION

Statistical evaluation of data pertaining to skeletal deposition of plutonium in rats of subgroups IVa, IVb, and IVd (see Table IV) which were sacrificed 4, 90, and 250 days, respectively, following cessation of

TABLE IV

AVERAGE PER CENT OF GASTROINTESTINAL ABSORPTION AND DEPOSITION OF PLUTONIUM FED TO RATS
(95 Per Cent Confidence Limits)

Group	Fraction of M.P.C. in Solutions Fed	Skeleton	Soft Tissues	Total
I	0.04	—	—	—
II	0.12	.00194± .00051	—	.00194± .00051
III	0.4	.00246± .00031	.00044± .00040	.00290± .00051
IVa	1.2	.00253± .00065	.00022± .00016	.00275± .00067
IVb	1.2	.00234± .00045	.00020± .00013	.00254± .00047
IVc	1.2	.00208± .00028	.00080± .00044	.00288± .00052
IVd	1.2	.00226± .00043	.00050± .00041	.00276± .00059
IV combined	1.2	*.00234± .00028	†.00021± .00010	†.00261± .00038

* Combined values for Group IV were obtained by pooling weighted components of subgroups IVa, IVb, and IVd. (See text under Discussion.)

† Combined values for Group IV were obtained by pooling weighted components of subgroups IVa and IVb. (See text under Discussion.)

plutonium feedings reveals that no significant differences exist among those values. Results of radiochemical analyses of skeletal plutonium deposition in rats which were sacrificed 180 days after completion of feedings (subgroup IVc) indicate a significant decrease, but this value is considered to be the result of experimental error due to the low levels of activity assayed, the length of the experiment, and the complexity of the laborious plutonium extraction procedure used. This is taken to justify the conclusion that no significant decrease in skeletal plutonium content occurred during the experimental feeding period. A pooling of values for subgroups IVa, IVb, and IVd yields 0.00234 ± 0.00028 per cent at the 95 per cent confidence interval for the mean deposition in skeletal tissue for rats in Group IV which received 1.2 times the maximum permissible concentration of plutonium.

Similar statistical analyses of the observed plutonium concentrations in soft tissues suggested that any pooling of results in the subgroups comprising Group IV would best be limited to those of IVa and IV*b*. Values from IVc. and IVd were discarded on the basis that turnover of plutonium from soft tissue may be reasonably expected to be more rapid than from bone,[1] and hence IVc and IVd should have shown less plutonium than IVa or IVb. The same statistical treatment applies to the combined total plutonium concentration shown in Table IV. All data were considered separately for male and female animals, but no correlation with sex was observed.

These results are lower by a factor of 2 to 3 than values previously reported. Carritt *et al.*[1] administered a total of 488 micrograms of plutonium to 3 rats in 5 equally divided doses during a period of five consecutive days. Animals were sacrificed four days after the last plutonium administration and an oral absorption of 0.01 per cent was reported by these workers. Scott *et al.*[7] calculated that 0.007 per cent of a single dose consisting of 15 micrograms of plutonium was absorbed from the gastrointestinal tract of rats. The lowest concentration levels of plutonium previously fed to rats were administered in this laboratory during an experiment preliminary to the present study.[5] Ten rats (5 males and 5 females) each were fed 5.9 micrograms of plutonium over a period of ninety days and an average of 0.0095 per cent of the administered dose was deposited in the total carcass. Even these levels, however, were several thousand times greater than the accepted M.P.C. for plutonium in drinking water.

On the basis of data collected in this experiment, there appears some evidence that the concentration of the plutonium fed may exert some effect on the amount absorbed and deposited. Thus, for skeleton, the mean deposition in per cent of amount fed seems to vary significantly from group to group. An experiment is currently in progress involving the feeding of plutonium solutions over a wide concentration range from 10 to 50,000 times the M.P.C. By comparing data from low-level and high-level feedings, it may become possible to obtain more conclusive evidence relative to the effect of plutonium concentration present in the lumen of the gastrointestinal tract on fraction absorbed. Discrepancies in coefficients of absorption calculated from the present study and from earlier work may have been due to such concentration effects.

The calculation of the maximum permissible concentration of plutonium in drinking water must not be based only on average values of plutonium deposited. It must place emphasis on individual variation in order to set up standards which will protect the exceptional as well as the average individual. With this in mind, Table V was prepared. Here are found statistical estimates of the maximum per cent of gastrointestinal absorption to be expected in 99 per cent of the experimental rats, 90 per cent of the time. In spite of the pessimistic bias embodied in these values, the limiting per cent of gastrointestinal absorption falls below the 0.01 per cent which has previously been accepted as the best experimental average value for the rat.

The presently accepted M.P.C. for plu-

TABLE V

MAXIMUM PER CENT OF GASTROINTESTINAL ABSORPTION AND DEPOSITION OF PLUTONIUM IN 99 PER CENT OF RATS 90 PER CENT OF THE TIME

Group	Skeleton	Soft Tissue	Total
I	—	—	—
II	.0047	.0027	.0074
III	.0050	.0038	.0088
IVa	.0062	.0009	.0071
IVb	.0043	.0008	.0051
IVc	.0033	.0027	.0060
IVd	.0039	.0019	.0058

tonium in water (1.5×10^{-6} μc./ml.) is based on an assumed absorption coefficient of 0.1 per cent.[3] This is a factor of approximately 10 higher than the absorption coefficient determined by previous workers using small numbers of animals and high concentrations of plutonium; and a factor of 40 higher than the absorption coefficient measured in the present experiment. In view of the consistency of the data obtained in the present study, the large number of animals employed, and the low concentration levels employed, it would seem reasonable to accept a value of 0.01 per cent for the absorption coefficient. This would still leave a safety factor of 4 to take care of unusual individual variation and the possibility of species variation between the rat and man. Using 0.01 per cent for the absorption coefficient the M.P.C. for plutonium in water would become 1.5×10^{-5} μc./ml.

SUMMARY

1. The gastrointestinal absorption and deposition of plutonium in bone and soft tissue of 160 rats after 517 low-level feedings of Pu^{238} were determined at doses that varied from 0.04 to 1.2 times the currently accepted maximum permissible concentration of plutonium in drinking water. Within the 95 per cent limits of confidence, the mean per cent total, soft tissue, and skeletal deposition was 0.00261 ± 0.00038, 0.00021 ± 0.00010, and 0.00234 ± 0.00028 respectively for animals receiving plutonium levels equivalent to 1.2 times the maximum permissible concentration.

2. No significant decrease in skeletal plutonium was observed over a period of 250 days following cessation of feedings.

3. The concentration of plutonium fed appeared to exert some effect on amount absorbed and deposited, but this will be investigated by further experimentation.

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Representatives on the American Board of Radiology: Douglas Quick, New York, N. Y., B. P. Widmann, Philadelphia, Pa., Frederick W. O'Brien, Boston, Mass.

Committee on Arrangements: Ralph M. Caulk, Chairman, Washington, D. C. Murray M. Copeland, Washington, D. C., John V. Blady, Philadelphia, Pa., Robert L. Brown, Emory University, Ga., John E. Wirth (ex officio), Pasadena, Calif.

Representatives on National Committee on Radiation Protection: Edith H. Quimby, New York, N. Y., Theodore P. Eberhard, Philadelphia, Pa.

Thirty-seventh Annual Meeting: Shoreham Hotel, Washington, D. C., April 21–23, 1955.

EDITORIAL

THE THIRTY-SEVENTH ANNUAL MEETING OF THE AMERICAN RADIUM SOCIETY

THE Thirty-seventh Annual Meeting of the American Radium Society will be held at the Shoreham Hotel in Washington, D. C., on Thursday, Friday, and Saturday, April 21, 22, and 23, 1955. This meeting immediately precedes the meeting of the Fifth Inter-American Congress of Radiology. Members of the latter and all others interested in therapeutic radiology, cancer research, therapy of malignant diseases in general, and radiological physics are cordially invited to attend.

The program will include at least two symposiums plus a number of widely diversified and interesting topics. Dr. Franklin L. Payne, of Philadelphia, will be moderator for one panel on the advantages or disadvantages of preoperative irradiation for cancer of the corpus uteri. Two persons will argue the affirmative, while two will take a contrary view. Discussion and comments from the floor will be welcomed.

Most clinicians as well as many persons interested in research will be delighted with a symposium on benign breast lesions simulating cancer as discussed by diagnostic and therapeutic clinicians, a pathologist, and an endocrinologist.

Individual papers include cancer of the urinary bladder; head and neck; the effects of radiation on the eye; vital stains demonstrating first effects of different types of radiation; research on time dose relationships; duration of human cancer, as estimated from tumor growth rate; and research on radiation measuring equipment.

It is anticipated that the Janeway Lecture, always a highlight of the meeting, will be held immediately after an informal dinner on the first night of the meeting, April 21, 1955. The annual banquet of the Society will be held on the second evening of the meeting, Friday, April 22.

The Shoreham Hotel offers excellent facilities for such a meeting and although most of the American Radium Society meetings are relatively small (150–200), this meeting may have a much larger attendance. Reservations are already two to three times the number anticipated by this time of year, so all members wishing accommodations at the hotel should arrange for them promptly through Mr. L. Gardner Moore, Manager, Shoreham Hotel, Washington 8, D. C.

A preliminary program will be forwarded to the members of the American Radium Society within the next two months and should appear in this JOURNAL in the March or April issue.

The program will be amply diversified to allow sufficient time for members and guests to take advantage of the many other scientific, educational, and recreational facilities offered in Washington.

Members or guests who have not received more specific information about the meeting from the Secretary of the Society may obtain it by writing directly to Dr. Robert E. Fricke, Mayo Clinic, Rochester, Minnesota; or to Dr. Ralph M. Caulk, Chairman of Committee on Arrangements, Garfield Hospital, 10th and Florida Avenue, N.W., Washington, D. C.

JOHN E. WIRTH, M.D., *President*
American Radium Society
635 East Union St.
Pasadena 1, California

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

MEETINGS OF ROENTGEN SOCIETIES*

United States of America

American Roentgen Ray Society
Secretary, Dr. Barton R. Young, Germantown Hospital, Philadelphia 44, Pa. Annual meeting: Palmer House, Chicago, Ill., Sept. 20–23, 1955.

American Radium Society
Secretary, Dr. R. E. Fricke, Mayo Clinic, Rochester, Minn. Annual meeting: Shoreham Hotel, Washington, D. C., April 21–23, 1955.

Radiological Society of North America
Secretary, Dr. D. S. Childs, 713 E. Genesee St., Syracuse 2, N. Y. Annual meeting: 1955, to be announced.

American College of Radiology
Executive Secretary, William C. Stronach, 20 N. Wacker Drive, Chicago 6, Illinois. Annual meeting: Drake Hotel, Chicago, Ill., Feb. 9–12, 1955.

Section on Radiology, American Medical Association
Secretary, Dr. T. Leucutia, Harper Hospital, Detroit 1, Mich.

Fifth Inter-American Congress of Radiology
Secretary-General, Dr. Eugene P. Pendergrass, 3400 Spruce St., Philadelphia 4, Pa. Meets at Shoreham Hotel, Washington, D. C., April 24–29, 1955.

Alabama Radiological Society
Secretary, Dr. J. A. Meadows, Jr., Medical Arts Bldg., Birmingham 5, Ala. Meets time and place Alabama State Medical Association.

Arizona Radiological Society
Secretary, Dr. R. Lee Foster, 507 Professional Bldg., Phoenix, Ariz. Two regular meetings a year. The annual meeting at time and place of State Medical Association and interim meeting six months later.

Arkansas Radiological Society
Secretary, Dr. J. A. Norton, 843 Donaghey Bldg., Little Rock, Ark. Meets every three months and also at time and place of State Medical Association.

Atlanta Radiological Society
Secretary, Dr. Albert A. Rayle, Jr., 478 Peachtree St., N.E., Atlanta, Ga. Meets monthly, except during three summer months, on second Friday evening.

Brooklyn Roentgen Ray Society
Secretary, Dr. J. J. Daversa, 345 75th St., Brooklyn, N. Y. Meets monthly fourth Tuesday, October through April.

Buffalo Radiological Society
Secretary, Dr. Clayton G. Weig, 135 Linwood Ave., Buffalo, N. Y. Meets second Monday evening each month, October to May inclusive.

Central New York Roentgen Ray Society
Secretary, Dr. Dwight V. Needham, 608 E. Genesee St., Syracuse, N. Y. Meets January, May, November.

Central Ohio Radiological Society
Secretary, Dr. F. A. Riebel, 15 West Goodale St., Columbus, Ohio. Meets at 6:30 P.M. on second Thursday of October, December, February, April, and June at Columbus Athletic Club, Columbus, Ohio.

Chicago Roentgen Society
Secretary, Dr. E. Burns Lewis, 670 N. Michigan Ave., Chicago 11, Ill. Meets second Thursday of each month, October to April inclusive at the University Club.

Cleveland Radiological Society
Secretary, Dr. H. F. Inderlied, 11311 Shaker Blvd., Cleveland 4, Ohio. Meetings at 6:45 P.M. on fourth Monday of each month from October to April.

Colorado Radiological Society
Secretary, Dr. S. A. Patterson, Larimer County Hospital, Fort Collins, Colo. Meets third Friday of each month at University of Colorado Medical Center or at Denver Athletic Club.

Connecticut Valley Radiologic Society
Secretary, Dr. B. B. Alicandri, 20 Maple St., Springfield, Mass. Meets second Friday October and April.

Dallas-Fort Worth Radiological Club
Secretary, Dr. O. H. Grunow, 650 Fifth Ave., Fort Worth, Texas. Meets monthly, third Monday, at Greater Fort Worth International Airport at 6:30 P.M.

Detroit Roentgen Ray and Radium Society
Secretary, Dr. E. F. Lang, Harper Hospital, Detroit, Mich. Meets monthly first Thursday, Oct. through May, at David Whitney House, 4421 Woodward Ave., at 6:30 P.M.

East Bay Roentgen Society
Secretary, Dr. Dan Tucker, 434 30th St., Oakland 9, Calif. Meets first Thursday each month at Peralta Hospital, Oakland.

Florida Radiological Society
Secretary, Dr. J. T. Shelden, Box 1021, Lakeland, Fla. Meets twice annually, in the spring with the annual State Society meeting, and in the fall.

Georgia Radiological Society
Secretary, Dr. Herbert M. Olnick, 417 Persons Bldg., Macon, Ga. Joint meeting with Florida State Medical Association, November, 1954.

Greater Miami Radiological Society
Secretary, Dr. R. D. Shapiro, 541 Lincoln Rd., Miami Beach, Fla. Meets monthly at various South Florida Hospitals.

Houston Radiological Society
Secretary, Dr. Harry Fishbein, 324 Medical Arts Bldg., Houston 2, Texas. Meets fourth Monday each month at Hermann Hospital.

Idaho State Radiological Society
Secretary, Dr. Alfred M. Stone, St. Lukes Hospital, Boise, Idaho. Meets annually at same time as Idaho State Medical Association.

Illinois Radiological Society
Secretary, Dr. Stephen L. Casper, 1101 Maine St., Quincy, Ill. Meets three times a year.

Indiana Roentgen Society
Secretary, Dr. John A. Robb, 238 Hume-Mansur Bldg., Indianapolis 4. Meets first Sunday in May and during fall meeting of Indiana State Medical Association.

Iowa Radiological Society
Secretary, Dr. James T. McMillan, 1104 Bankers Trust Bldg., Des Moines, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society, The scientific section is held in the autumn.

Kansas Radiological Society
Secretary, Dr. A. M. Cherner, Hays, Kansas. Meets in spring with State Medical Society, and in winter on call.

Kentucky Radiological Society
Secretary, Dr. David Shapiro, 323 East Chestnut St., Louisville 2, Ky. Meets monthly on second Friday at Seelbach Hotel, Louisville.

Kings County Radiological Society
Secretary, Dr. Solomon Maranov, 1450 51st St., Brooklyn 19, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:45 P.M.

* Secretaries of societies are requested to send timely information promptly to the Editor.

Los Angeles Radiological Society
Secretary, Dr. Oscar Harvey, 3741 Stocker St., Los Angeles 8, Calif. Meets second Wednesday each month at Los Angeles County Medical Association Building, Los Angeles.

Maine Radiological Society
Secretary, Dr. W. A. Russell, Augusta General Hospital, Augusta, Maine. Meets in June, October, December and April.

Maryland Radiological Society
Secretary-Treasurer, Dr. Paul W. Roman, 1810 Eutaw Place, Baltimore 17, Maryland.

Memphis Roentgen Society
Secretary, Dr. B. E. Greenberg, 294 Annella St., Memphis 11, Tenn. Meets first Monday of each month at John Gaston Hospital.

Miami Valley Radiological Society
Secretary, Dr. G. A. Nicoll, 134 Apple St., Dayton, Ohio. Meets second Friday of fall and winter months.

Mid-Hudson Radiological Society
Secretary, Dr. J. W. Walton, Horton Memorial Hospital, Middletown, N. Y. Meets 8:30 P.M., fourth Tuesday each month, September to May.

Milwaukee Roentgen Ray Society
Secretary, Dr. R. W. Byrne, 3321 N. Maryland Ave., Milwaukee 1, Wis. Meets monthly on fourth Monday at University Club.

Minnesota Radiological Society
Secrrtary, Dr. John R. Hodgson, Mayo Clinic, Rochester, Minn. Meets three times annually, once at time of State Med. Assn., and in spring and fall.

Mississippi Radiological Society
Secretary, Dr. John W. Evans, 117 N. President St., Jackson, Miss. Meets third Thursday of each month at Hotel Edwards, Jackson, at 6:00 P.M.

Montana Radiological Society
Secretary, Dr. Grant P. Raitt, Suite 413 Medical Arts Bldg., Billings, Montana. Meets at least once a year.

Nassau Radiological Society
Secretary, Dr. Alan E. Baum, Hicksville, N. Y. Meets second Tuesday of the month in February, April, June, October and December.

Nebraska Radiological Society
Secretary, Dr. J. F. Kelly, Jr., 816 Medical Arts Bldg., Omaha, Nebr. Meets third Wednesday of each month at 6 P.M. in Oamaha or Lincoln.

New England Roentgen Ray Society
Secretary, Dr. Stanley M. Wyman, Massachusetts General Hospital, Boston, Mass. Meets third Friday of each month, October through May, at Hotel Commander, Cambridge, Mass.

New Hampshire Roentgen Ray Society
Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

New York Roentgen Society
Secretary, Dr. Sidney Rubenfeld, 477 First Ave., New York 16, N. Y. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

North Carolina Radiological Society
Secretary, Dr. W. C. Sternbergh, Charlotte Memorial Hospital, Charlotte, N. C. Meets in May and October.

North Dakota Radiological Society
Secretary, Dr. Marianne Wallis, St. Joseph's Hospital, Minot, N. Dak. Meetings by announcement.

North Florida Radiological Society
Secretary, Dr. Ivan Isaacs, 1645 San Marco Blvd., Jacksonville, Florida. Meets quarterly in March, June, September and December.

Northeastern New York Radiological Society
Secretary, Dr. D. H. Baxter, Albany Hospital, Albany, N. Y. Meets in Albany area on second Wednesdays of October, November, March and April.

Northern California Radiological Society
Secretary, Dr. H. B. Stewart, 2920 Capitol Ave., Sacramento, Calif. Meets at dinner last Monday of each month, September to June.

Ohio State Radiological Society
Secretary, Dr. M. M. Thompson, Jr., 319 Toledo Medical Bldg., Toledo 2, Ohio.

Oklahoma State Radiological Society
Secretary, Dr. John R. Danstrom, Medical Arts Bldg., Oklahoma City, Okla. Three regular meetings annually.

Oregon Radiological Society
Secretary, Dr. F. C. Shipps, 214 Medical-Dental Bldg., Portland 5, Oregon. Meets monthly from October to June on the second Wednesday of each month at 8:00 P.M. at the University Club.

Orleans Parish Radiological Society
Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

Pacific Northwest Radiological Society
Secretary, Dr. J. R. Raines, 214 Medical-Dental Bldg., Portland 5, Oregon. Meets annually in May.

Pacific Roentgen Society
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

Pennsylvania Radiological Society
Secretary, Dr. J. M. Converse, 416 Pine St., Williamsport. Next annual meeting at Berkshire Hotel, Reading, Penna., May 20 and 21, 1955.

Philadelphia Roentgen Ray Society
Secretary, Dr. H. M. Stauffer, Temple University Hospital, Philadelphia 40, Pa. Meets first Thursday of each month, at 5 P.M., from October to May in Thompson Hall, College of Physicians.

Pittsburgh Roentgen Society
Secretary, Dr. Donald H. Rice, Western Pennsylvania Hospital, Pittsburgh 24, Pa. Meets second Wednesday of month, October through June at Hotel Roosevelt.

Radiological Section, Baltimore Medical Society
Secretary, Dr. Paul W. Roman, 1810 Eutaw Place, Baltimore 17, Md. Meets third Tuesday each month, September to May, inclusive.

Radiological Section, Connecticut Medical Society
Secretary, Dr. William A. Goodrich, 85 Jefferson St., Hartford 6, Conn. Meetings are held bi-monthly.

Radiological Section, Southern Medical Association
Secretary, Dr. Roy G. Giles, Temple, Texas.

Radiological Society of Greater Cincinnati
Secretary, Dr. Wm. R. Dickens, Cincinnati General Hospital, Cincinnati 29, Ohio. Meets monthly from September to June on first Monday of each month at 7:30 P.M. at the Cincinnati General Hospital.

Radiological Society of Hawaii
Secretary, Dr. H. C. Chang, 1282 Emma St., Honolulu 13, T. H. Meets third Monday evening of each month at designated hospitals.

Radiological Society of Greater Kansas City
Secretary, Dr. E. H. Stratemeier, Jr., 1010 Rialto Building, Kansas City 6, Mo. Meets last Friday of each month.

Radiological Society of Kansas City
Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

Radiological Society of Louisiana
Secretary, Dr. J. T. Brierre, 700 Audubon Bldg., New Orleans. Meets annually during Louisiana State Medical Society Meeting.

Radiological Society of New Jersey
Secretary, Dr. Carye-Belle Henle, 195 North 7th St., Newark, N. J. Meets at Atlantic City at time of State Medical Society and in November in Newark, N. J.

Radiological Society of Southern California
Secretary, Dr. George Jacobson, 1200 N. State St., Los Angeles 33, Calif.

Richmond County Radiological Society
Secretary, Dr. W. F. Hamilton, Jr., University Hospital, Augusta, Ga. Meets first Thursday of each month at various hospitals.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. Henry H. Forsyth, Jr., 40 Meigs St., Rochester, N. Y. Meets at 8:15 P.M. on the last Monday of

each month, September through May, at Strong Memorial Hospital.

Rocky Mountain Radiological Society
Secretary, Dr. John H. Freed, 4200 East Ninth St., Denver 7, Colo.

St. Louis Society of Radiologists
Secretary, Dr. W. B. Seaman, 510 South Kingshighway, St. Louis 10, Mo. Meets fourth Wednesday each month, except June, July, August and September.

San Antonio-Military Radiological Society
Secretary, Dr. Hugo F. Elmendorf, Jr., 730 Medical Arts Bldg., San Antonio 5, Texas Meets Brooke Army Medical Center Officers Mess first Monday of each month.

San Diego Radiological Society
Secretary, Dr. C. W. Bruner, 2456 Fourth Ave., San Diego 1, Calif. Meets first Wednesday of each month at the University Club.

San Francisco Radiological Society
Secretary, Dr. T. M. Fullenlove, 110 El Verano Way, San Francisco 27, Calif. Meets quarterly at Grison's Steak House.

Section on Radiology, California Medical Association
Secretary, Dr. H. R. Morris, 1027 "D" St., San Bernardino, Calif.

Section on Radiology, Medical Society of the District of Columbia
Secretary, Dr. John A. Long, 1801 K St., N.W., Washington 6, D. C. Meets Medical Society Library, third Wednesday of January, March, May and October at 8:00 p.m.

Section on Radiology, Illinois State Medical Society
Secretary, Dr. George E. Irwin, Jr., 703 N. East St., Bloomington, Ill.

Shreveport Radiological Club
Secretary, W. R. Harwell, 608 Travis St., Shreveport, La. Meets monthly on third Wednesday, at 7:30 p.m. September to May inclusive.

South Bay Radiological Society
Secretary, Dr. H. R. Berman, 309 St. Claire Bldg., San Jose, Calif. Meets second Wednesday of each month.

South Carolina Radiological Society
Secretary, Dr. William A. Klauber, Self Memorial Hospital, Greenwood, S. C. One meeting with South Carolina Medical Association in May, others arranged by President.

Tennessee Radiological Society
Secretary, Dr. G. K. Henshall, 311 Medical Arts Bldg., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

Texas Radiological Society
Secretary, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas. Next meeting, Houston, Texas, January 21 and 22, 1955.

Tri-State Radiological Society
Secretary, Dr. S. N. Tager, 219 Walnut St., Evansville, Ind. Meets last Wednesday of Oct., Jan., March and May, 8:00 p.m. at Elks' Club in Evansville.

University of Michigan Department of Roentgenology Staff Meeting
Meets each Monday evening from September to June, at 7:00 p.m. at University Hospital.

University of Wisconsin Radiological Conference
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets first and third Thursdays 4:00 to 5:00 p.m., September to May, Service Memorial Institute.

Utah State Radiological Society
Secretary, Dr. Angus K. Wilson, 343 S. Main St., Salt Lake City 1, Utah. Meets fourth Wednesday in January, March, May, September and November at Holy Cross Hospital.

Virginia Radiological Society
Secretory, Dr. P. B. Parsons, Norfolk General Hospital, Norfolk, Va. Meets annually in October.

Washington State Radiological Society
Secretary, Dr. Eva L. Gilbertson, 1317 Marion St., Seattle 4, Wash. Meets fourth Monday of each month from September through May at 610 Pine St., Seattle.

West Virginia Radiological Society
Secretary, Dr. W. Paul Elkin, 515 Medical Arts Bldg., Charleston, W. Va. Meets concurrently with annual meeting of West Virginia State Medical Society; other meetings arranged by program committee.

Westchester Radiological Society
Secretary, Dr. M. G. Priestman, New Rochelle Hospital, New Rochelle, N. Y. Meets on third Tuesday of January and October and on two other dates.

Wisconsin Radiological Society
Secretary, Dr. W. W. Moir, 309 Geele Ave., Sheboygan, Wis. Special meetings held during year; annual meeting each spring at Madison, Wis.

X-Ray Study Club of San Francisco
Secretary, Dr. Wm. W. Saunders, Veterans Administration Hospital, San Francisco 21, Calif. Meets monthly, third Thursday at 7:45 p.m., Lane Hall, Stanford University Hospital.

Cuba, Mexico, Puerto Rico and Central America

Sociedad de Radiología y Fisioterapia de Cuba
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

Sociedad Mexican de Radiología, A. C.
Secretary General, Dr. Eugenio Toussaint, Calle del Oro No. 15, Mexico 7, D.F. Meets first Monday of each month.

Asociación Puertorriqueña de Radiología
Secretary, Dr. Rafael A. Blanes, Ave. Ponce de Leon 1175, Santurce, P. R.

Sociedad Radiológica Panameña
Secretary, Dr. L. Arrieta Sanchez, Apartado No. 86, Panama, R. de P. Meets monthly in a department of radiology of a local hospital, chosen at preceding meeting.

British Empire

Association of Radiologists of the Province of Quebec
Secretary, Dr. Jean-Louis Léger, 1560 Sherbrooke St., Montreal, Que. Meets four times a year.

British Institute of Radiology Incorporated with the Röntgen Society
Ordinary meeting, on the Thursday preceding the third Friday, October to May at 8:15 p.m.
Medical Members' meeting, on third Friday in each month at 5:00 p.m., 32 Welbeck St., London, W 1

Faculty of Radiologists
Honorary Secretary, Dr. J. F. Bromley, 45, Lincoln's Inn Fields, London, W.C.2, England.

Section of Radiology of the Royal Society of Medicine (Confined to Medical Members)
Meets third Friday each month at 4:45 p.m. at the Royal Society of Medicine, 1 Wimpole St., London.

Canadian Association of Radiologists
Honorary Secretary-Treasurer, Dr. D. L. McRae, Suite 305, 1555 Summerhill Avenue, Montreal 25, Que. Meetings January and June.

Section of Radiology, Canadian Medical Association
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

Société Canadienne-Française d'Electro-Radiologie Médicales
General Secretary, Dr. Ls Ivan Vallée, 1058 rue St-Denis, Montreal 18, Canada. Meets third Saturday each month.

College of Radiologists (Australia and New Zealand)
Honorary Secretary, Dr. Alan R. Colwell, c/o British Medical Agency, 135 Macquarie St., Sydney, N.S.W.

South America

Asociacion Argentina de Radiologia
Secretary, Dr. Lidio G. Mocsa, Avda. Gral. Paz 151, Córdoba, Argentina. Meetings held monthly.

Sociedad Argentina de Radiologia, Junta Central, Buenos Aires
Secretary, Dr. Oscar F. Noguera, Santa Fe 1171, Buenos Aires. Meetings are held monthly.

SOCIEDAD ARGENTINA DE RADIOLOGIA, FILIAL DEL LITORAL, SEDE, ROSARIO
President, Dr. Francisco P. Cifarelli. Meets monthly second Wednesday, 19 ha 663 Italia St., Rosario, Santa Fe.

SOCIEDAD ARGENTINA DE RADIOLOGIA, FILIAL DEL SUR, SEDE, LA PLATA
President, Prof. Dr. Jose P. Uslenghi, La Plata. Meets monthly.

SOCIEDAD ARGENTINA DE RADIOLOGIA, FILIAL DEL CENTRO SEDE, CÓRDOBA
President, Prof. Dr. David L. Caro, Corro 86, Córdoba. Meets monthly.

SOCIEDAD ARGENTINA DE RADIOLOGIA, FILIAL DEL NORTE, SEDE, TUCUMAN
President, Dr. Julio Mendez Valladares, Rivadavia 358, Tucuman. Meets monthly.

SOCIEDAD ARGENTINA DE RADIOLOGIA, FILIAL DE CUYO SEDE, MENDOZA.
President, Dr. J. A. Orfila, Hospital Central, Mendoza. Meets monthly.

SOCIEDADE BRASILEIRA DE RADIOLOGIA MEDICA
Secretary, Dr. Nicola Caminha, Av. Mem. de Sa, Rio de Janeiro, Brazil. Meets monthly, except during January, February and March.

SOCIEDADE BRASILEIRA DE RADIOTERAPIA
Secretary, Dr. Oscar Rocha von Pfuhl, Av. Brigadeiro Luiz Antonio, 644 São Paulo, Brazil. Meets monthly on second Wednesday at 9:00 P.M. in São Paulo at Av. Brigadeiro Luiz Antonio, 644.

SOCIEDAD COLOMBIANA DE RADIOLOGIA
Secretary, Dr. Luis E. Lozano B., Carrera 12 No. 20–69, 6° piso, Bogota, Colombia. Meets last Thursday of each month.

SOCIEDAD PERUANA DE RADIOLOGIA
Secretary General, Dr. Amador Holgado V. Apartado 2306, Lima, Peru. Meets monthly except during January, February and March, at Asociación Médica Peruana "Daniel A. Carrión," Villalta, 218, Lima.

SOCIEDAD DE RADIOLOGICA, CANCEROLOGIA Y FISICA MEDICA DEL URUGUAY
Secretary, Dr. Arias Bellini, Av. Agraciada 1464, Piso 13, Montevideo, Uruguay.

CONTINENTAL EUROPE

SOCIÉTÉ BELGE DE RADIOLOGIE
General Secretary, Dr. S. Masy, 111 Avenue des Allies, Louvain, Belgium. Meets monthly, second Sunday at Maison des Médecins, Brussels.

SOCIÉTÉ FRANÇAISE D'ELECTRO-RADIOLOGIE MÉDICALE, and its branches: SOCIÉTÉ DU SUD-OUEST, DU LITTORAL MÉDITERRANÉEN, DU CENTRE ET DU LYONNAIS, DE L'OUEST, DE L'EST, ET D'ALGER ET D'AFRIQUE DU NORD
Secretary-General, Dr. A. Dariaux, 9 bis, Boulevard Rochechouart, Paris IX^{e}, France.

CESKOSLOVENSK SPOLEČNOST PRO RËNTGENOLOGII A RADIOLOGII V PRAZE
Secretary, Dr. Roman Bláha, Praha XII, stát. nemocnice, Czechoslovakia. Meets monthly except during July, August, and September. Annual general meeting.

DEUTSCHE RÖNTGEN-GESELLSCHAFT
Secretary, Dr. med. Peter Kröker, Evangelisches Krankenhaus, Huyssens Stiftung, (22a) Essen.

SOCIETA ITALIANA DI RADIOLOGIA MEDICA
Secretary, Prof. Mario Ponzio, Ospedale Mauriziano. Torino, Italy. Meets biannually.

NEDERLANDSE VERENIGING VOOR ELECTROLOGIE EN ROENTGENOLOGIE
Secretary, Dr. B. J. Rethmeier, Bornsestraat 378, Almelo, Netherlands.

POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw Poland.

GDANSK SECTION, POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. A. Smigielska, Akademia Lekarska, Gdansk. Meets monthly last Sunday at 10:30, X-Ray Dept., Akademia Gdansk.

WROCLAW SECTION, POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. R. Marciniak, Akad. Medyczna Wroclaw, 68 Curie-Sklodowska St., Wroclaw, Poland. Meets first Sunday of each month, X-Ray Department, Akademia Medyczna Wroclaw.

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE
Secretary, Dr. Oscar Meller, Str. Banual Mărăcine, 30, S.I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD
USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

SCANDINAVIAN ROENTGEN SOCIETIES
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

SOCIEDAD ESPANOLA DE RADIOLOGIA Y ELECTROLOGIA
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7, Madrid, Spain. Meets monthly in Madrid.

SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT (SOCIÉTÉ-SUISSE DE RADIOLOGIE)
Secretary, Dr. Max Hopf, Effingerstrasse 47, Bern, Switzerland.

INDIA

INDIAN RADIOLOGICAL ASSOCIATION
Secretary, Dr. R. F. Sethna, Navsari Building, Hornby Road, Bombay 1, India.

SYMPOSIUM ON FUNDAMENTAL CANCER RESEARCH

The Ninth Annual M. D. Anderson Symposium on Fundamental Cancer Research will be held on March 10, 11 and 12, 1955, at the University of Texas, M. D. Anderson Hospital and Tumor Institute in the Texas Medical Center, Houston.

The first day of the program will be a review of the current research projects at the hospital. This will be followed in the evening by the first formal gathering for the Symposium: a discussion of "The Epidemiology of Cancer" by Miss Eleanor Macdonald of the Anderson Hospital staff, followed by a presentation on "Experimental Design" by Dr. John Fertig, Professor of Columbia University Medical School, Department of Statistics.

The second day of the Symposium will be devoted to "The Histochemistry of Cancer." Dr. George Gomori of the University of Chicago, who will be the Chairman of this program, has chosen six national figures as speakers.

The third and final day of the Symposium will be devoted to presentations reflecting current cancer research in the Southwest for which Dr. A. Clark Griffin of M.D. Anderson Hospital has assembled an interesting series of papers.

The Bertner Award for outstanding contribution in the field of cancer will be made the evening of March 11, 1955, at a banquet to be held at the Doctors' Club in the Jesse Jones Library Building of the Texas Medical Center, Houston, Texas.

COURSE SCHEDULE OF OAK RIDGE INSTITUTE OF NUCLEAR STUDIES

The Oak Ridge Institute of Nuclear Studies has announced the following course schedule:

Basic Courses in the Techniques of Using Radioisotopes: January 10–February 4; February 21–March 18; May 2–May 25 (special class for noncitizens); June 6–July 1; July 11–August 5; August 15–September 9, 1955.

Industrial Uses of Sealed Radioactive Sources: April 18–29, 1955.

Basic Survey Medical Course: May 16–21, 1955.

In addition, the Institute is contemplating a fall course in clinical techniques of isotope use at the technician level, and is asking for inquiries and suggestions relative to the need and conduct of such a session.

The *Basic Radioisotope Techniques Courses* are open to scientists in all fields and are designed for individuals starting work with isotopes.

Industrial Uses of Sealed Radioactive Sources will be held in two sections, and participants may enroll for one or both weeks:

"Safe Handling of Sealed Sources," the first week, is designed for personnel in a position to direct or teach others in the uses of radioactive sources. Its purpose is to familiarize enrollees with various sealed sources, and with some of the problems involved in their handling, with particular emphasis on radiation hazards and methods in personnel safety; a background for understanding the basic principles of radioactivity will be provided. Lectures will deal with practical industrial problems concerning such subjects as detection of radioactive materials, biological effects of radiation, and radiation protection; laboratory experiments will be performed on commercially available sealed sources and will cover such topics as shielding, wipe tests, plotting of isodose curves, scattering, inverse square law, and radiography.

The second week, "Industrial Applications of Sealed Sources," is intended for supervisory personnel, and will present surveys of uses of both the gamma-emitting sealed sources and beta-gauging devices. A review of typical techniques will be given, and it is expected that a number of manufacturers of sealed sources will send representatives to demonstrate their products. Lecture subjects will concern the design and selection of sources, radiography, gauging devices, instrumentation, location and storage of equipment, and legal aspects in the use of radioisotopes. Discussion periods will be devoted to problems brought up by the participants, manufacturers' representatives, and the staff.

The *Basic Survey Medical Course* will emphasize routine clinical applications of radioiodine, radiophosphorus, radiogold, and teletherapy, and will be basic in nature.

Further information and application blanks may be had by writing Dr. Ralph T. Overman, Chairman, Special Training Division, Oak Ridge Institute of Nuclear Studies, P. O. Box 117, Oak Ridge, Tennessee.

RADIATION BALANCE

A radiation balance microcalorimeter recently developed by Dr. W. B. Mann of the

National Bureau of Standards precisely determines the emission rate of low activity radioactive sources. The instrument does this by measuring the minute amounts of heat energy which accompany radioactive emission. The device is extremely compact and requires a relatively short time to complete a determination. It can be used to determine the intensity of a single source or to compare two sources of nearly equivalent energy emission.

A primary function of the National Bureau of Standards is the custody and maintenance of the national standards of physical measurement to meet the needs of science and industry. The Bureau's first standard of radioactivity was brought to this country by Marie Curie in 1913. Subsequently two Hönigschmid radium standards were acquired to calibrate and compare all of the radium sources produced and sold in this country. With the development of atomic energy and the tremendously increased use of radioisotopes, the demand for National Bureau of Standards certification of radioactive sources increased appreciably. To accommodate this new work, the radiation balance was developed and investigated as a possible supplement to existing instruments. It is capable of rapid, accurate determinations, and is expected to aid materially in the certification work.

A calorimeter embodying the principles used in this radiation balance was first described by H. L. Callendar in 1910. With this calorimeter, which he called a radio-balance, Callendar made measurements of solar radiation and also carried out a somewhat preliminary measurement of the energy emitted in unit time from a sealed source of radon. Since that time, apart from a determination of the Stefan-Boltzmann radiation constant by Hoare in the early 1930s, no other reference to the radio-balance has occurred in the scientific literature.

GEORGIA RADIOLOGICAL SOCIETY

The Georgia Radiological Society met jointly with the Florida Radiological Society at Ponte Vedra Beach on November 20 and 21, 1954. Dr. H. S. Weens, Professor of Radiology at Emory University School of Medicine, addressed the gathering on "Basic Considerations in Intravenous Cholangiography." A joint film reading session and separate business sessions were held.

BOOK REVIEWS

Books sent for review are acknowledged under Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interest of our readers as space permits.

THE ROENTGENOLOGIST IN COURT. By Samuel Wright Donaldson, M.D., Roentgenologist, St. Joseph Mercy Hospital, Ann Arbor, Michigan. Second edition. Cloth. Price, $7.75. Pp. 358. Charles C Thomas, Publisher, 301 East Lawrence Avenue, Springfield, Illinois, 1954.

This book now occupies a place of its own in medical literature. It is the one reliable authority on its subject, a subject which is assuming more and more importance, not to the radiologist alone but to all practitioners of medicine.

In matters pertaining to the law the doctor finds himself in a new world which is strange to him and which he enters usually with fears and misgivings. The second edition of Dr. Donaldson's book, like the first, helps to dispel his fears and furnishes him with information and advice which will enable him to conduct himself with honor and confidence when he is called to act as a witness or to defend himself in damage suits.

The book is easy to read, interesting throughout, but many sections require and deserve careful and detailed study. Excellent advice is given upon how to avoid and how to defend oneself in malpractice suits; how to conduct oneself as a witness in liability suits in courts of law and before compensation boards; upon the rights and duties of the doctor as an expert witness; upon the legal status of the physician as an employee of an institution or group, or as the member of a partnership; and upon numerous other questions with which every doctor for his own safety should be familiar.

Every physician should take note of a statement repeated more than once in various connections in this book, namely, that a considerable percentage of malpractice suits against doctors are directly attributable to injudicious, careless, or even malicious remarks of some member of the medical profession. Dr. Donaldson's emphasis upon this unfortunate fact should impel every doctor to memorize and take to heart two verses of the Thirty-Ninth Psalm, quoted by Dr. Osler in his famous book, "Aequanimitas": "I said I will take heed to my ways, that I offend not in my tongue. I will keep my mouth as it were with a bridle."

"The Roentgenologist in Court" is a book for every practitioner of medicine, but it has a unique and highly important place in the library, or rather on the desk, of the radiologist.

A. C. CHRISTIE, M.D.

LEHRBUCH DER RÖNTGENOLOGISCHEN DIFFERTIALDIAGNOSTIK. Bant I. Erkrankungen der Brustorgane. Von Werner Teschendorf, Köln. Dritte, verbesserte und wesentlich erweiterte Auflage. Cloth. Price, DM 129.-. Pp. 954, with 1030 illustrations. Georg Thieme, Diemershaldenstrasse, 47, Stuttgart, Germany (Grune & Stratton, Inc., New York, New York), 1952.

This is the first volume of a two volume work on roentgenological differential diagnosis. This volume takes up Diseases of the Organs of the Chest. The second volume concerns the Abdominal Organs. The arrangement of the book is in many ways unusual. The four main divisions are differential diagnosis of the roentgen appearance of the lungs, of the heart, of the esophagus and of the diaphragm. Within these main chapters, the text is not arranged according to diseases, but rather according to gross roentgenological changes. For instance, the main chapters of the differential diagnosis of the roentgen appearance of the lung are: 1. Opacification of one-half of the chest. 2. Opacification of individual parts of the lung. 3. The different forms of tuberculosis. 4. Differential diagnosis of round and large foci in the lung. 5. Differential diagnosis of fine mottling in the lung. 6. Differential diagnosis of linear shadows in the lung. 7. Cavities and other abnormal air-containing spaces in the chest. 8. Differential diagnosis of bronchiectasis and contrast filling of the bronchi. 9. Differential diagnosis of the hilar area. 10. Differential diagnosis of changes in the mediastinal shadow. This unusual approach creates difficulties for the reader who is looking for some specific information. An excellent index helps somewhat to overcome this difficulty. It permits one to find the place of the principal discussion of the various diseases, and also the references to other lesions which might

be important in the differential diagnosis.

The main objection to the purely descriptive rather than etiologic system of the book, however, is the fact that such a system seems hardly to be recommended for the teaching of the young physician who should learn to understand radiology as applied pathology. In addition, the book appears antiquated in various places, for instance in the illustration of interlobar effusions where it represents viewpoints which have long proved to be erroneous.

The experienced reader will recognize the shortcomings, but will also often find this book with its unconventional approach interesting and stimulating.

The illustrations are excellent and so is the printing.

RICHARD SCHATZKI, M.D.

LEHRBUCH DER RÖNTGENDIAGNOSTIK. Von H. R. Schinz, W. E. Baensch, E. Friedl, E. Uehlinger nebst Beiträgen von E. Brandenberger, A. Brunner, U. Cocchi, N. P. G. Edling, J. Eggert, F. K. Fischer, M. Holzmann, H. Krayenbühl, Å. Lindbom, E. Lindgren, G. A. Preiss, S. Welin, A. Zuppinger. Fünfte, völlig neu bearbeitete und vermehrte Auflage. 7. Lieferung. Innere Organe. Paper. DM 89.-. Pp. 454, with 516 illustrations. Georg Thieme, Diemershaldenstrasse, 47, Stuttgart, Germany (Grune & Stratton, Inc., New York, New York), 1952.

LEHRBUCH DER RÖNTGENDIAGNOSTIK. Von H. R. Schinz, W. E. Baensch, E. Friedl, E. Uehlinger nebst Beiträgen von E. Brandenberger, A. Brunner, U. Cocchi, N. P. G. Edling, J. Eggert, F. K. Fischer, M. Holzmann, J. Krayenbühl, Å. Lindbom, E. Lindgren, G. A. Preiss, S. Welin, A. Zuppinger. Fünfte, völlig bearbeitete und vermehrte Auflage. 8. Lieferung. Innere Organe. Paper. Price DM 96.-. Pp. 449, with 559 illustrations. Georg Thieme, Diemershaldenstrasse, 47, Stuttgart, Germany (Grune & Stratton, Inc., New York, New York), 1952.

The comments in review of the previous volumes of this work apply to these last two volumes. Volume 7 deals with the aorta and peripheral vessels to complete the cardiovascular system, and then carries the presentation of the alimentary tract from mouth through small intestine and appendix.

Volume 8 continues the discussion of the alimentary tract with sections on the colon, liver, gallbladder, and biliary ducts. The pancreas, spleen and adrenals are also allotted separate sections. Then an extensive section deals with the genitourinary systems and roentgen diagnosis in pregnancy.

Another example of the ramifications of this work is the 20-page chapter in Volume 8 on the hereditary factors in abnormalities of the alimentary and genitourinary tracts, replete with genealogical tables.

HENRY G. MOEHRING, M.D.

THE BREAST IN ROENTGEN DIAGNOSIS. By Raul A. Leborgne, M.D., Head of Radiologic Department of the Instituto de Radiología y Centro de Lucha contra el Cáncer, Hospital Pereira Rossell, Montevideo, Uruguay. English translation by Lucy Crocker de Leborgne. Cloth. Pp. 200, with 307 illustrations. Impresora Uruguaya S. A., Juncal, 1511, Montevideo, Uruguay, 1953.

The author for years has systematically studied the value of plain and contrast mammography in the diagnosis of various lesions of the breast and has made numerous important contributions to the literature.

In this excellent book he now gives a detailed account of the present status of the method by drawing liberally upon the vast clinical and roentgenological material of the Instituto de Radiología y Centro de Lucha contra el Cáncer of Montevideo from which most of the work originated.

The subject is divided into seven chapters, two dealing with the author's technique of mammography, including intraductal biopsy and intraductal rinse and the roentgenologic anatomy of the breast, and five relating in extenso to the pertinent findings in carcinoma, fibrocystic mastopathy, fibroadenoma, mastitis and some rarer lesions of the breast. The text is richly illustrated with photographs, photomicrographs, artist's drawings and especially with reproductions of many beautiful mammograms permitting direct comparison with photographs of the surgical specimens.

It is the author's considered opinion that, although the technique of examination and the interpretation of the roentgen findings will undoubtedly be further improved, the results already obtained justify the recommendation of the systematic use of the method as a complement to clinical study in all cases of mammary complaints.

The book is well written and its printing and engravings are of the highest quality. It is primarily intended for roentgenologists but will also prove very useful to surgeons and to everyone interested in an investigative approach to the diseases of the breast.

T. Leucutia, M.D.

Gastric Cancer. By Alfred H. Iason, M.D., Attending Surgeon, Adelphi Hospital; Director of Surgery, Brooklyn Hospital for the Aged; Surgeon, Manhattan General Hospital; Instructor in Anatomy, New York Medical College and Flower Hospital. Illustrations by Alfred Feinberg, Instructor of Medical Illustration, Department of Pathology, College of Physicians and Surgeons, Columbia University, New York, New York. Cloth. Price, $7.50. Pp. 316, with 98 illustrations. Grune & Stratton, Inc., 381 Fourth Avenue, New York 16, New York, 1953.

This book presents a moderately comprehensive review of much of the available knowledge of cancer arising in the stomach and distal esophagus. Beginning with a detailed discussion of the anatomy of the upper gastrointestinal tract, the Histology, Incidence, Etiology, Pathology, Symptomatology, Diagnosis, Preparation, Anesthesia, Surgery, Post-Surgical Treatment, Complications and Prognosis of gastric cancer are dealt with in order.

The clinical management of patients with cancer of the stomach is discussed in some detail. A good bibliography is appended but rarely does the author call upon his own experiences to clarify controversial points. Some of the concepts presented, particularly in regard to parenteral fluid therapy, are outmoded. Likewise, some newer supplementary measures, such as the use of efocaine as a long-acting local anesthetic agent for the control of postoperative intercostal neuralgia, are ascribed an importance which is open to question. Little reference is made to the controversial subject of extending the use of total gastrectomy in early gastric cancer.

The book is attractively bound in blue velum and is well illustrated. The major operative procedures utilized in gastric surgery are well described and illustrated but ten photomicrographs of the rare squamous cell carcinoma of the stomach are ambiguously reproduced without editorial comment.

The radiologist will find this a helpful book primarily as a source for general information concerning gastric cancer, outside of his own field.

Frederick A. Coller, M.D.

The Roentgen Aspects of the Papilla and Ampulla of Vater. By Maxwell H. Poppel, M.D., F.A.C.R., Professor of Radiology, New York University Post-Graduate Medical School; Director of the Roentgen Ray Department, Bellevue Hospital; Consultant in Radiology, Veterans Administration Hospital, Bronx, New York; Consulting Radiologist, United States Naval Hospital, St. Albans, Long Island; Roentgenologist, New York University Hospital; Harold G. Jacobson, M.D., F.A.C.R., Director, Department of Roentgenology, Hospital for Special Surgery; Associate Clinical Professor of Radiology, New York University Post-Graduate Medical School, New York, New York; Attending in Radiology, U. S. Veterans Administration Hospital; Formerly, Chief, Radiology Service, U. S. Veterans Administration Hospital, Bronx, New York; and Robert W. Smith, M.D., Senior Resident in Radiology, Veterans Administration Hospital, Bronx, New York. Cloth. Pp. 211, with 150 illustrations. Charles C Thomas, Publisher, 301 East Lawrence Avenue, Springfield, Illinois, 1953.

This little monograph covers quite extensively a rather limited subject. It is in a way an appendix to the larger work of the senior author.

Anatomy, embryology, and physiology of the lower end of the common bile duct are all described at length, with emphasis of course on the roentgenological aspects. The technique of examination is detailed and many interesting examples of demonstration of the ampullas are shown. The limited number of diseases which are involved is likewise exhaustively covered from the point of view of diagnosis, and it is here that the volume is most characteristically a supplement to "The Roentgen Manifestation of Pancreatic Disease."

Throughout, the presentation is orderly and clear. Detailed information is available for those who want it, but the organization of the volume is such that it is easy to find the answer to a specific question without unnecessary detail.

The index is good, and a large number of excellent illustrations enhances the practical value of the volume. The book would be of

value to surgeons and internists if only to display some of the possibilities of roentgen diagnosis. It is a companion volume to "The Roentgen Manifestation of Pancreatic Disease."

E. F. Lang, M.D.

A Collection of Urogenital Drawings. By William P. Didusch. Pp. 222, with 243 figures and legends, some in color. Cystoscope Makers, Inc., 1241 Lafayette Avenue, New York 59, New York, 1952.

This atlas represents illustrations of genitourinary anatomy, anomalies, and pathology selected from over 4,000 drawings made by the author, a medical artist, between the years 1915 and 1952.

The illustrations appear in both black and white, and in color. They are magnificantly drawn in every detail to the extent that they appear real. The drawings were made from specimens taken at the operating or autopsy table, or as observed through the cystoscope.

The atlas is well organized, beginning with several detailed drawings of the anatomy of the genitourinary system. This is followed by the selected pathological specimens of the genital and urinary organs: kidney, ureter, bladder, prostate, urethra, penis, scrotum, genital abnormalities, and adrenal diseases.

This is one of the best atlases of gross pathology which the reviewer has seen. It is well recommended for any private or hospital library, particularly for the urologist and the radiologist.

Robert C. Thumann, M.D.

Contact Dermatitis. By George L. Waldbott, M.D., F.A.A.A., F.A.C.A., F.I.A.A., F.A.C.P., Senior Physician, Harper Hospital; Chief of Division of Allergy, Assistant Physician, Grace Hospital; Chief of Allergy Clinic, Formerly, Director of Allergy Clinic, Children's Hospital of Michigan; Formerly, Consultant Allergist, St. Mary's Hospital and North End Clinic, Detroit, Michigan. Cloth. Price, $8.75. Pp. 232, with 322 illustrations. Charles C Thomas, Publisher, 301 East Lawrence Avenue, Springfield, Illinois, 1953.

The administration of roentgen therapy and treatment of skin eruptions does not always necessitate knowledge of the etiologic factor involved, but the radiologist acquainted with potential etiologic factors is a better consultant, both for the patient and referring physician. This book, therefore, should be of great interest to any radiologist whose practice includes the treatment of skin lesions.

The text of this monograph bears upon the practical side of the subject, avoiding details of chemical analysis and presenting the material much as a physician might manage a case in his office.

Dr. Waldbott states that careful observation of the pattern of dermatitis produced by certain objects is by far the most reliable clue for the detection of its cause. This is particularly well illustrated by patterns on the hand, where a large number of dermatological lesions occur. He also demonstrates the manner in which these patterns might be altered by secondary infection or irritant medication. A comparison with similar skin lesions, such as atopic dermatitis, seborrheic dermatitis, fungus infection, stasis dermatitis, nummular eczema and many other common skin conditions aids in differentiating these lesions from contact dermatitis. The list of potential irritants includes numerous common household and office items, as well as drugs, cosmetics, plants and occupational hazards. Concise charts and tables make this book particularly practical, correlating the causative agent with the skin surface usually involved. A practical approach to therapy is also presented as well as the diagnostic criterion. The book contains over a hundred excellent illustrations and many charts and tables which simplify the intricate detective task involved in determining the cause of contact dermatitis. The book presents an original concept and a new approach to the diagnosis and management of troublesome skin eruptions.

K. K. Latteier, M.D.

Third Annual Report on Stress. By Hans Selye, M.D., Ph.D. (Prague), D.Sc. (McGill), F.R.S. (Canada), Professor and Director of the Institut de Médecine et de Chirurgie expérimentales, Université de Montréal; and Alexander Horava, M.D. (Lausanne), Research Associate and Librarian of the Institut de Médecine et de Chirurgie expérimentales, Université de Montréal. Cloth. Pp. 637, with illustrations. Acta, Inc., 5465 Decarie Boulevard, Montreal 29, Quebec, Canada, 1953.

This volume on stress follows the pattern of the two previous reports, covering the complete literature of 1953 dealing with stress. Dr.

Selye again enlists the services of Dr. Alexander Horava, research associate and librarian of the Institute of Medicine and Experimental Surgery at the University of Montreal. Stress, as shown in this and the previous volume and reports on this subject, reaches into every branch of medicine. This volume represents a tremendous amount of "organized and well coordinated effort covering the vast field of stress." The amount of detailed effort going into this third volume is shown by the fact that there are 5,741 references, with elaborate indexing and cross-indexing. What a tremendous growth this subject has had is evidenced by the fact that "the entire series offers a classified guide system to approximately 20,271 references on stress, the adaption syndrome and the adaptive hormones." The author reference index is made conspicuous by being given on yellow paginal marking. Part I deals with general physiology and pathology of stress; Part II with special physiology and pathology of stress, and Part III is termed "After Thoughts, Sketch for a Unified Theory of Medicine." These special chapters require concentrated reading. The concepts advanced are supported by the experimental work of Selye and associates as well as others. A new feature of the third volume is the addition of three special articles namely: (1) "Hypertension," by D. M. Green. (2) "Neurophysiological aspects of the control of ACTH secretion," by R. W. Porter. (3) "The effects of bilateral total adrenalectomy in diabetics with advanced vascular disease," by J. T. Wortham and J. W. Headstream.

The concept of the general adaptation syndrome (G. A. S.) is given in the first part of the book and there is also given a detailed explanation how to use the book. The authors again state, as they did previously, that "these books are obviously not meant to be read from cover to cover." The reading is not easy and requires a knowledge of abbreviations used and fortunately there are six pages devoted to definitions and terminology. Anyone interested in the adaptation syndrome in any field will need these reference books.

Robert C. Moehlig, M.D.

Annual Review of Nuclear Science. Volume 2. J. G. Beckerley, Editor. Cloth. Price, $6.00. Pp. 429, with numerous illustrations. Annual Reviews, Inc., Stanford, California, 1953.

This second volume of the Annual Review of Nuclear Science differs from the first of the series in that it omits references to the biomedical aspects of radiation. It consists of sixteen articles competently written by authorities in the field covering the literature to as late as July, 1952.

Four chapters survey and discuss subjects of astronomical and geochemical interest in the light of known nuclear reactions. They are: (a) Origin and propagation of cosmic rays, by Biermann; (b) The origin and abundance distribution of the elements, by R. A. Alpher and R. C. Herman; (c) Energy production in stars, by E. E. Salpeter, and (d) The production and distribution of natural radiocarbon, by E. C. Anderson. With the exception of the first which, in parts, is of necessity highly mathematical, these articles are engrossingly written and cannot fail to be enjoyed by the inquiring mind. The microcosmos of the atomic nucleus and its consequences is the concern of the rest of the volume; thus three articles by Templeton, Strauch, and Spence and Ford, respectively, discuss results of the interaction of high energy particles and photons with nuclei, whereas four chapters by Frauenfelder, Konopinski and Langer, Coryell and Feld survey the properties of nuclei and the radiations emitted by them. These articles, though rather highly specialized, are interestingly written and far from being a series of annotated bibliographies, contain comments and useful criticisms. An article on recent progress in accelerators by Chu and Schiff covers the kevatron-bevatron range with perception of important details and remarkable economy of space. Blair and Chew offer a critical analysis of our knowledge of subnuclear particles (mesons) and Breit and Gluckstern delve into the advances of nucleon-nucleon scattering experiments and their theoretical consequences. The remaining two articles by Dienes and Bigeleisen survey respectively the radiation effects in solids and chemical properties of matter which are affected by the nuclear mass.

It is difficult to state to what extent a volume of this sort may interest a radiologist or a radiobiologist. The radiological physicist and the radiochemist interested in keeping up the general trend of the field will like to consult it. As a ready source of reference, the extensive bibliographies attached to each chapter are invaluable.

L. D. Marinelli

ABSTRACTS OF RADIOLOGICAL LITERATURE

Department Editor: T. Leucutia, M.D., Harper Hospital, Detroit 1, Michigan

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ROENTGEN DIAGNOSIS

HEAD

MANCHESTER, P. THOMAS, JR. The x-ray diagnosis of orbital tumors. *South. M. J.*, March, 1954, *47*, 231–234.

The early diagnosis of orbital tumors is very difficult and very important since exploration of an orbit surgically is such a hazardous procedure that it should not be done unless there is a mass palpable somewhere in the orbit. Unilateral exophthalmos alone is not sufficient reason for exploring an orbit surgically.

The radiologist is very helpful to the ophthalmologist in the early diagnosis of orbital tumors. Such a diagnosis can be made in almost half the cases. The following signs should make one suspect a malignancy of the orbit and should be an indication for complete roentgenological studies:

1. Unilateral exophthalmos.
2. Retrobulbar neuritis or prolonged unilateral papilledema.
3. Ocular tumors which may have spread posteriorly.
4. Palpable mass.
5. Unilateral optic atrophy or unexplained field defect.

Increased soft tissue density, bone changes, or enlargement of the orbit may give one a clue to the diagnosis. New techniques which have been developed are laminagraphy, artificial orbital emphysema, cerebral arteriography, and orbitography.

Laminagraphy makes it possible to examine tissue in the orbit at various depths. Artificial orbital emphysema is produced by injecting from 10 to 30 cc. of air into the orbit and then making roentgenological studies. This may outline a tumor mass. Cerebral arteriography is of use mainly when "staining" occurs because this actually demonstrates the tumor itself.

The author describes orbitography in detail. This has been in use during the last year at Emory University in association with Dr. Jose Bonmati. The complications of the method include irritation and occasional necrosis. Preliminary injection of hyaluronidase prepares the tissues and has prevented this necrosis. The opaque material is then injected and outlines the tumor mass.

If all these methods fail to demonstrate the tumor mass, a short period of roentgen therapy followed by observation may reveal complete disappearance of the symptoms.—*Neal F. Yeomans, M.D.*

SHAPIRO, ROBERT, and ROBINSON, FRANKLIN. Controlled pneumoencephalography; a consideration of head position and gas-fluid replacement. *J. Neurosurg.*, March, 1954, *11*, 122–127.

The authors wish to re-emphasize the technique developed by Robertson and Lindgren, which evidently has not received in this country the attention it merits.

The method assures adequate visualization of the third and fourth ventricles, the sylvian aqueduct and the subarachnoid cisterns. Unlike prevalent techniques utilizing relatively large amounts of gas injected following lumbar puncture and aspiration of cerebral spinal fluid, this method depends essentially on the injection of gas following lumbar puncture and before removal of cerebral spinal fluid.

With the patient seated and the head slightly flexed, gas introduced by lumbar puncture into the subarachnoid space rises to the cisterna magna, then through the foramen of Magendie to the fourth ventricle, the aqueduct and the posterior portion of the third ventricle. Should these not be visualized on the roentgenograms, then minor adjustments in the position of the head will be necessary.

After removal of 5 to 8 cc of cerebrospinal fluid, additional gas (10 to 15 cc.) is injected (total 20 to 30 cc. of gas). Visualization of the sulci over the cerebral convexities may be obtained by injecting an additional 5 to 10 cc. with the head in marked flexion.

The success of this procedure requires attention to every detail and constant direction during the examination.

Reproductions of excellent roentgenograms with accompanying sketches are presented, together with a list of the recommended positions during the examinations.—*William H. Shehadi, M.D.*

MARAÑÓN, G., and ARMENGAUD, F. GALVEZ. Chronology of the sphenoidal sinus and its value in diagnosis. *Brit. M. J.*, April 3, 1954, *1*, 778–779.

This study is based on some 8,000 roentgenograms of the heads of normal subjects or of patients with only very minor complaints with the purpose of determining the appearance of the sphenoid sinus of normal individuals of both sexes at various ages and especially the normal or pathological development of the sphenoid sinus between the ages of 3 to 16 years.

Their conclusions are: (1) Dimensions and shape of the sphenoid sinus are subject to wide variations. These are less marked than variations of the frontal sinus; (2) chronology of development of the sphenoid sinus is graphically shown in an accompanying diagram; (3) the sphenoid sinus is first visible at fairly constant age, ranging between 3 and 3½ years. Normally the sphenoid sinus does not increase after 16 years of age; (4) in conditions of pituitary insufficiency, congenital or acquired, the development of the sphenoid sinus is hindered in variable degree. This is seen in pituitary dwarfism and infantilism, in myxedema of pituitary origin, and in mongolism.

The sinus is frequently solid in growth disturbances —namely, achondroplasty and other conditions. In cases of underdevelopment associated with other disorders not directly connected with the pituitary gland, like rickets and other deficiency diseases, the development of the sphenoid sinus is the average for age; (5) the degree of underdevelopment of the sphenoid sinus is, roughly speaking, parallel with the degree of the hypothalamo-pituitary insufficiency. It constitutes, therefore, one of the indices of this hypofunction especially in cases of pituitary dwarfism and infantilism. The underdevelopment of the child, determined by comparing his cranial roentgenogram with the authors' diagram, expresses, in cases of infantilism and dwarfism, the degree of inhibition of the general development in years. This corresponds exactly enough to that based on the comparison of the roentgenograms of the wrist or the knee with the classical graphs of development of epiphyseal growth cartilages and ossification centers of the peripheral skeleton; (6) underdevelopment of the sphenoid sinus is not exactly parallel with the underdevelopment of the other sinuses; (7) in cases of constitutional or pathological pituitary hyperfunction (acromegaly) the sphenoid sinus develops intensely, generally simultaneously with the other sinuses of the skull.

The final conclusion of these authors is that the detailed study of the sphenoid sinus is absolutely necessary when examining a pathological cranium, and especially in cases of growth disturbances.—*William Loehr, M.D.*

Neck and Chest

Stratemeier, E. H., and Barry, J. W. Torsion of the lung following thoracic trauma; a case report. *Radiology*, May, 1954, *62*, 726–727.

Numerous cases of thoracic and pulmonary trauma are reported in the literature. Descriptions are to be found of pneumothorax, hemohydrothorax, atelectasis, pulmonary edema, interstitial and alveolar hemorrhage, ruptured alveoli, and ruptured bronchi.

A review of the literature reveals no reports of thoracic injury such as that reported by the authors. Their patient, a six year old boy, died about seven hours following severe trauma to the chest. At autopsy the left lung was found to be inverted, with torsion at the root of the lung, massive pulmonary infarction on the left, and hemothorax. Multiple other injuries were present.

It is assumed that the sudden compression of the thorax, by the weight of the vehicle inflicting the injury, caused collapse of the lower lobe and forced it cephalad. When the pressure was suddenly relieved, the lower lobe re-expanded in its new position, with the upper lobe depressed and only partially re-expanded.

Roentgenograms of the chest, made immediately after the trauma, showed a peculiar striated pattern in the mid-portion of the left lung field. This striation extended from the hilus laterally and there swept upward in a curving fashion. There was bilateral pneumothorax, more pronounced on the left.—*Arno W. Sommer, M.D.*

Crellin, J. Antrim; Lehman, J. Stauffer; Mason, Daniel; and Curry, Joseph L. Bronchographic studies in bronchiectasis before and after pulmonary resection. *Am. Rev. Tuberc.*, May, 1954, *69*, 657–672.

Preoperative and postoperative bronchograms were obtained in 44 cases treated surgically for bronchiectasis. Special interest was directed toward a study of what changes, if any, occurred in the remaining segmental bronchi following resective surgery.

The clinical results of surgery were excellent in 26 cases, good in 13 and fair or poor in 5. Postoperative bronchograms revealed no evidence of residual or new bronchiectasis in the operated lung in 25 cases. In the remaining 19 cases, 4 had incomplete removal of the disease, 4 developed bronchiectasis as a result of complications following surgery, 10 developed bronchiectasis in what were considered normal bronchi prior to surgery.

In all these cases there was a variable degree of distortion of the bronchi remaining, suggesting that this hindered drainage and probably caused the development of new pathology.

There are excellent plates and drawings of 20 bronchograms.—*V. L. Peterson, M.D.*

Greening, Roy R., and Pendergrass, Eugene P. Postmortem roentgenography with particular emphasis upon the lung. *Radiology*, May, 1954, *62*, 720–725.

In a ten year period the authors obtained postmortem chest roentgenograms of over 300 cadavers. Correlations were made between the findings in antemortem, postmortem, and excised-tissue roentgenograms and those observed grossly and microscopically.

Their technique is described in detail. Roentgenograms are made in the position employed for the living subject. The body is suspended by means of an orthopedic traction apparatus with chin and occipital straps, a canvas strap beneath each axilla, and a belt to anchor the body firmly against the cassette holder. A No. 15 spinal needle, inserted into the trachea, permits free ingress of air into the lungs. After the roentgenograms are made, the thoracic contents are removed by the Rokitansky method. Roentgenograms of the reinflated lungs are made after removal.

The postmortem roentgenograms were compared with the antemortem studies and with the roentgeno-

grams of the excised lungs. It was found that many small lesions were being missed, and some relatively large lesions were not seen, even in restudy of the antemortem films.

The lesion most commonly escaping demonstration, on the routine conventional roentgen examination of the chest, was found to be the small calcified or uncalcified nodule 3 mm. or slightly more in diameter. It was also found that, in almost every patient with obvious metastatic disease, inflated, excised lung revealed many more nodules than had been suspected or could be identified in the antemortem study.

A third, although less common, type of lesion that is not demonstrated adequately is associated with some form of pneumoconiosis or lymphatic spread of cancer. Postmortem roentgenograms of the excised lungs in such cases have revealed diffuse nodulation, which was not seen on the antemortem films. Rarely a solitary nodule as much as 5 cm. in diameter may escape detection on conventional, technically good roentgenograms of the living patient, and likewise in the postmortem roentgenograms of the chest with all organs in situ.

It is concluded that conventional roentgenography, although good, leaves much to be desired. For that reason, an investigation of very high voltage ranges has been initiated for use in diagnostic radiology.—*Arno W. Sommer, M.D.*

Krech, William G., Storey, Clifford F., and Umiker, William C. Thymic cysts; a review of the literature and report of two cases. *J. Thoracic Surg.*, May, 1954, *27*, 477–493.

The authors divide thymic cysts into three groups: (1) congenital, (2) inflammatory, (3) neoplastic. Cysts resulting from infection appear invariably to be due to syphilis and were relatively more common in the past than they are now. Cysts occurring in thymic neoplasms can probably be attributed to degeneration and necrosis of the tumor.

The non-neoplastic, non-inflammatory cysts reported here are probably congenital in origin. The latter are thought related to branchial and cervical cysts and are usually derived from the third branchial pouch. The rarity of these tumors is exemplified by the fact that the literature contains reports of only 8 thymic cysts being resected. To these 8 the authors add 2 more.

Thymic cysts may be found in any position along a line extending from the mandibular angle to the cervical midline, thence down into the anterior mediastinum as far as the diaphragm. They may vary in size from 1 cm. in diameter to fist size, may be unilocular or multilocular and may have a long stalk. The lining epithelium is either cuboid or pavement-like. The cysts commonly contain fluid with fresh or old blood elements and other cellular debris.

Usually these cysts are asymptomatic and are discovered as incidental findings on chest roentgenograms. An accurate preoperative diagnosis is nearly impossible.

The cysts in the presently reported cases, males aged twenty-one and twenty-six years, were similarly discovered as incidental findings on chest roentgenograms. No definite symptoms could be attributed to the lesions.—*Paul C. Olfelt, M.D.*

Kalmon, Edmond H. Creeping eruption associated with transient pulmonary infiltrations. *Radiology*, Feb. 1954, *62*, 222–226.

Creeping eruption, known also as endemic cutaneous helminthiasis and larva migrans, is endemic in the costal areas of southeastern United States. Although usually a cutaneous disease, the author presents a case of Loeffler's syndrome which was probably caused by this organism. It is suggested that the organisms may follow the pattern of the hookworm, *Necator americanus*, to gain entrance into the lung. Other possibilities for the lung pathology are offered.

Roentgenograms showing the widely scattered small irregular areas of infiltration in each lung and their transitory nature on serial studies are reproduced.

Paroxysms of coughing were a prominent feature in the case presented, persisting as long as nine months after the skin and pulmonary lesions had cleared.—*Everett E. Seedorf, M.D.*

May, Ivan A., Garfinkle, Jack M., and Dugan, David J. Eosinophilic granuloma of lung: report of three cases. *Ann. Int. Med.*, March, 1954, *40*, 549–562.

The authors report 3 cases of eosinophilic granuloma of the lung. Two of the cases also had eosinophilic granuloma of bone. The third case had Hand-Schüller-Christian syndrome and a femoral bone lesion.

Eosinophilic granuloma of bone was described by Lichtenstein and Jaffe in 1940. Weinstein *et al.*, Dixon, Schuknecht and Perlman and Parkinson reported cases of multiple skeletal lesions with pulmonary infiltrations.

In the authors' series, Case 1 occurred in a forty year old male, who showed on roentgenograms a destructive lesion of the right fifth posterior rib. At operation two small peripheral nodules were found in the upper lobe of the lung. Although the pathological diagnosis of the frozen sections was undifferentiated carcinoma, the final diagnosis on permanent sections was eosinophilic granuloma.

The second case occurred in a twenty-eight year old housewife, who presented a palpable mass involving the midportion of the left ninth rib. Roentgenograms made in November, 1950, were interpreted as showing clear pulmonary fields and a destructive lesion of the left ninth rib. The rib lesion

was resected and histopathological examination revealed an eosinophilic granuloma. In May, 1952, roentgenograms of the chest showed a diffuse miliary granular infiltration of both lungs. Review of the roentgenograms of 1950 showed a similar pulmonary involvement in an early stage. Biopsy of the pulmonary lesion revealed eosinophilic granuloma.

The third case was that of thirty-six year old housewife with the chief complaint of shortness of breath. Roentgenograms showed right pneumothorax and diffuse symmetrical fibrosis. A right thoracotomy revealed a diffusely granular lung. Biopsy was interpreted as eosinophilic granuloma. Bone survey revealed a poorly defined radiolucent zone in the neck of the left femur. This patient also had diabetes insipidus and questionable exophthalmos. Although roentgenograms of the skull did not reveal any bony abnormality, the case is regarded as an instance of Hand-Schüller-Christian disease. Pathologically, the lesions are of a xanthogranulomatous nature, occasionally with collections of eosinophils. The authors believe that this offers further evidence that eosinophilic granuloma of bone and Hand-Schüller-Christian disease are variants of one basic pathologic process.—*J. N. Ané, M.D.*

Lutwyche, V. Ursula. The differential diagnosis of carcinoma of the bronchus and pulmonary tuberculosis. *Lancet*, April, 3, 1954, *1*, 693–695.

The close similarity which may exist between the roentgenological appearance of a bronchial carcinoma and that of pulmonary tuberculosis is well known.

The 7 cases described include 5 where the correct diagnosis was not reached until it was too late to benefit the patient. In the other 2 cases the correct diagnosis was made early in the illness. These patients are now alive and well six and three years later respectively.

A study of these 7 cases, all middle-aged or elderly men, shows several points of interest. First, it is important to hesitate before accepting a diagnosis of pulmonary tuberculosis in people of this age, unless tubercle bacilli have been found in the sputum; in 5 of these 7 cases repeated examination of the sputum failed to reveal tubercle bacilli. The not infrequent occurrence of cavitation in association with a bronchial carcinoma is emphasized.

Secondly, not every bronchial carcinoma is visible through the bronchoscope. A report of a normal bronchial tree does not necessarily exclude the presence of a carcinoma. In 3 of the 7 cases described, bronchoscopy showed nothing abnormal when the examination was first made. In 1 case the true diagnosis was made four weeks later when the examination was repeated. In another, the diagnosis was established from a biopsy taken from the depths of the bronchial orifice. These 2 patients are the only survivors of the 7.

It is well known that patients with a bronchial carcinoma often present a history of recent bronchitis or other respiratory infection. Four of the 7 patients described gave such a history. Another factor which may obscure the true diagnosis is the improvement in general condition and the alleviation of symptoms when the patient is confined to bed. This improvement was considerable in 3 of the 7 cases, and in 2 of them it was accompanied by definite improvement in the roentgenological appearance.

The diagnosis of bronchial carcinoma at an early stage is seldom easy. If the prognosis is to be improved this diagnosis should constantly be borne in mind, particularly when a middle-aged man has suspicious symptoms or an unexplained shadow in the chest is present. All patients with abnormal shadows which cannot be adequately explained on another basis should have the benefit of surgical exploration. —*Stephen N. Tager, M.D.*

Levin, Bertram, and Rigler, Leo G. Rib notching following subclavian artery obstruction. *Radiology*, May, 1954, *62*, 660–670.

Notching of the ribs was formerly considered pathognomonic of coarctation of the aorta. Experience has shown, however, that there are other causes, some of which are: arteriovenous fistula of the intercostal vessels, intercostal arteriosclerosis, neurofibromas of the intercostal nerves, arteriovenous fistula of the chest wall vessels, idiopathic dilatation and tortuosity of the intercostal arteries and varicosities of intercostal veins.

The authors report a series of 8 cases with slight to moderate rib erosion due to a cause heretofore unreported. In all these cases there was obstruction of the third portion of the subclavian artery, secondary to unsuccessful Blalock-Taussig operation. The collateral arterial circulation through the intercostal arteries readily accounts for the rib changes.

In conclusion, the authors state that roentgenographic evidences of ipsilateral rib notching following a Blalock-Taussig procedure should arouse suspicion that the anastomosis is no longer patent.—*Donald N. Dysart, M.D.*

Figley, M. M. Accessory roentgen signs of coarctation of the aorta. *Radiology*, May, 1954, *62*, 671–687.

The most commonly recognized signs of coarctation of the aorta are rib notching and a small aortic arch. Both frontal and oblique views of the aorta should show indentation in the aortic shadow indicating the site of coarctation. Fluoroscopically, one should see increased pulsation in the ascending aorta as compared to that observed in the descending aorta. The barium-filled esophagus is usually displaced at the level corresponding to the aortic deformity.

Pathologically adult coarctation is characterized

by a short, nearly complete obstruction at or below the ligamentum arteriosum. There is usually a medial and interior buckling of the aorta presumed due to traction by the ligamentum. Not only is there dilatation of the ascending aorta, but dilatation below the coarctation may occur as a result of entry of blood from dilated intercostals.

After reviewing the films of 75 patients with coarctation of the aorta, the author concluded that the most useful accessories to rib notching are visible aortic deformity and esophageal displacement.

The following table lists the frequency of the various roentgen signs of aortic coarctation in the author's series:

(Figures in parentheses indicate number of assessible cases.)

Rib notching (74)	
Present	77%
Absent	23%
Left mediastinal contour (71)	
Normal	32.5%
Lateral	55.0%
Convex	12.5%
Retrosternal scalloping (74)	
Present	28.5%
Left ventricular size (74)	
Normal	60%
Slightly enlarged or hypertrophied	21%
Moderately or markedly enlarged	19%
Esophageal course	
Subarch deviation	
Frontal (34)	53%
Left oblique (42)	80%
Small arch impression (28)	75%
Aortic contour	
Descending (66)	
Normal	40.0%
Abnormal, but not diagnostic	18.5%
Discontinuous	37.5%
Aneurysmal	4.0%
Deformity in left oblique (52)	30.0%
Ascending (73)	
Normal	67%
Prominent	33%
Aortic "knob"	
Normal	57%
Small	25%
Large	18%
Pulse deficit (36)	83%

In a few instances angiography was of aid in making a definite diagnosis. The article is illustrated with 14 excellent figures.—*Everett E. Seedorf, M.D.*

KEATING, D. R., and AMBERG, J. R. A source of potential error in the roentgen diagnosis of cervical ribs. *Radiology*, May, 1954, *62*, 688–694.

Costal processes, cervical ribs, and normal thoracic ribs are identical in embryogenesis, distinction between them being made on the basis of length, configuration, and relation to individual vertebrae.

The authors point out that the costal processes of the seventh cervical vertebra are independent of the transverse processes in childhood and may be so conspicuous as to suggest cervical ribs on routine chest films.

Since fusion of the costal and transverse processes of the seventh cervical vertebra does not usually occur until the fourth to the tenth year, a potential source of error in the diagnosis of cervical ribs exists in early childhood where the costal processes are unusually long in relation to the transverse processes. True cervical ribs exist as such since birth, however, and exhibit the anterior and downward curvature of all true ribs.

Keeping this in mind, the diagnosis of cervical rib in early childhood will be made with caution and only when the proper criteria are met and normal variations excluded.—*Michael J. Healy, M.D.*

GOLDRING, DAVID, ROGERS, HENRY M., JR., TER-POGOSSIAN, MICHAEL, SEAMAN, WILLIAM, and BEHRER, M. REMSEN. Radiocardiography in congenital heart disease. *J. Pediat.*, April, 1954, *44*, 392–406.

The purpose of this study was to explore the technique of radiocardiography as a possible diagnostic aid in children with congenital heart disease. This method was first described and used by Prinzmetal and associates.

During the past fifteen months this method was employed in over 100 children with congenital cardiac defects and 22 children with normal hearts. Cases of congenital heart disease selected were those in which the diagnosis was verified by angiocardiography or catheterization. In most cases the diagnosis was established operatively.

The instrument used in this investigation was a scintillation counter fitted with a sodium iodide, thallium activated crystal. The efficiency of this counter for the detection of gamma rays emitted by I^{131} was approximately 50 per cent. The output of the scintillation counter was fed into a counting rate meter connected to an Esterline-Angus graphic recorder. The response of the counting rate meter to the signal supplied by the scintillation counter was exponential with respect to time.

A single counter was employed and placed over the midsternal line at the fourth interspace. Sterile diiodofluorescein tagged with I^{131} was used. Ten microcuries of diiodofluorescein, representing a volume of approximately 0.05 cc., were carefully measured in a tuberculin syringe, and a venipuncture was performed in the antecubital fossa. The entire extremity was elevated above heart level. At a given signal the injection was made as rapidly as possible with the recording device running at a constant

speed. No sedation was used in order to simplify the procedure.

A control group of 20 normal children between the ages of two and ten years was first studied. The type of curve obtained showed a prompt rapid initial upswing which occurred within three seconds after injection of the radioactive material, followed by a less rapid down swing to form the first peak of the curve. The duration of this curve was twelve to thirteen seconds when measured from the beginning of the upward deflection to the lower point reached by the descending limb. This was usually followed by a low, flat-peaked secondary rise beginning sixteen to seventeen seconds after injection and lasting ten seconds or less. A final base line was reached which was 40 to 50 per cent of the maximum amplitude of the first peak.

Four children with uncomplicated patent ductus arteriosus were studied before and after surgical ligation. Preoperatively, the radiocardiogram in all 4 children showed a prompt rise after injection, followed by a down swing which tended to be prolonged. No second peak was observed. Following surgical ligation, an appreciable change in contour was noted.

Two patients with Eisenmenger complex were examined in a similar manner, and the curves were much like those obtained in patients with a patent ductus. At present no explanation is given for the striking similarity of the tracings in these two types of congenital malformations.

Five patients with tetralogy of Fallot had radiocardiograms before operation. Examination of the curves revealed, a prompt, almost vertical rise after injection of the dye. A narrow peak was formed as the descending limb fell abruptly. In three of the five curves a secondary rise was seen which occurred two to three seconds earlier than in the normal curves. The marked difference in contour between the tracings of Eisenmenger complex and tetralogy of Fallot was most striking.

The method of radiocardiography was found to be simple and safe. Diiodofluorescein was preferred as the test substance due to the easy availability, rapid excretion, and eight day half-life of I^{131} in contrast to radioactive sodium.

The true significance of the radiocardiogram is still imperfectly understood. The two upward deflections of the radiocardiogram represent first right, then left heart concentration of the radioactive substance. The authors believe that it may be chiefly the activity in the right heart that is reflected in the tracing.

The tracings obtained with the method used in this study are grossly similar to the dye dilution curves in cyanotic congenital heart disease recently reported by Swan and associates who employed Evans blue and followed the dilution of this dye in the blood stream with an earpiece oximeter. They believe that distinctive dye dilution curves can be obtained in different congenital cardiac malformations.

It is doubtful whether the curves will prove to be specific for the many other different types of cardiac anomalies. Cases of congenital heart disease which tend to produce dilatation or hypertrophy of the right auricle, right ventricle, or both, may prove to show similar tracings.

The striking difference in the radiocardiographic tracings obtained in Eisenmenger complex and tetralogy of Fallot suggests that this method may prove valuable in their differential diagnosis without resorting to catheterization or angiocardiography.

More studies are needed in normal children and those with congenital heart disease to determine the influence of such factors as tachycardia, congestive failure, and respiration on the character of the radiocardiograms.—*Stephen N. Tager, M.D.*

Disenhouse, Robert B., Anderson, Ray C., Adams, Paul, Jr., Novick, Rosalind, Jorgens, Joseph, and Levin, Bertram. Atrial septal defect in infants and children *J. Pediat.*, March, 1954, *44*, 269–289.

An isolated atrial septal defect may be the cause for death and since surgical correction is now possible it is important to make the diagnosis as early as possible. The authors present the findings on 21 patients on whom the diagnosis of atrial septal defect was established by cardiac catheterization and an additional 6 patients on whom the diagnosis was made at postmortem study. Symptoms vary considerably but, on the whole, feeding difficulties, recurrent respiratory infection, and growth retardation were the chief complaints. Cardiac failure may occur early in life. There are no typical or pathognomonic physical findings. Specifically, clinical findings were much more variable in the infant group and accurate diagnosis was therefore more difficult. The authors did not note underdevelopment of their small children as has been previously emphasized. No typical electrocardiographic picture was obtained, though right axis deviation and right ventricular hypertrophy were frequently observed. Roentgenographically, the typical pictures showed enlargement of the right atrium and right ventricle with dilatation of the pulmonary artery. Left atrial enlargment was absent in all cases and this aided in the differentiation occasionally from a patent ductus. Except in the infant group there was no correlation between the heart size and general condition of the patient. As has been previously reported, cardiac catheterization is the best method for substantiating the diagnosis. Left-to-right shunt was found in every case and the authors were able to pass the catheter through the defect in approximately 50 per cent of their cases.

Three cases underwent successful surgical closure of the atrial defect.—*Lawrence A. Davis, M.D.*

Adams, Ralph, and Luria, Sidney B. Uncommon benign lesions of lower esophagus, diaphragm, and cardia. *J.A.M.A.*, Feb. 20, 1954, *154*, 662–665.

The authors review the case histories of several patients, together with the roentgen, surgical and pathological findings in some unusual benign lesions of the lower esophagus and cardia of the stomach. In one patient a gastric diverticulum was found at fluoroscopy. At esophagoscopy, a hemangioma 4 mm. in diameter was noted at the junction of esophagus with stomach, and a punctate ulcer in the center of the hemangioma. At surgery, two additional small ulcers of the mucosa were found. All of these lesions were removed, with relief of symptoms for the patient.

In another patient with repeated diagnoses of congestive heart failure and coronary thrombosis, a large paraesophageal herniation of the stomach was found. The hernia was repaired and relief of symptoms followed.

One patient complained of epigastric pain, difficulty in swallowing, and a recent weight loss of 15 pounds. Fluoroscopic examination revealed a stricture in the distal third of the esophagus, with dilatation of the esophagus above this point. An ulcerated area, about 1.5 cm. in diameter, was demonstrated on the posterior wall of the lower esophagus. This was confirmed at esophagoscopy. Biopsy revealed chronic inflammation. Preoperative diagnosis was "probable carcinoma." At surgery a mass was found involving the distal third of the esophagus and upper portion of stomach, and measuring 8 by 4 cm. The mass was resected, and an esophagogastrostomy was done. Pathological examination showed an inflamed, tiny diverticulum of the lower esophagus with chronic, suppurative, granulomatous periesophagitis.

Another patient presented a history of lack of appetite, progressive weight loss, increasing constipation, and upper lumbar back pain. At fluoroscopy a large fixed, irregular mass and ulcer were found in the fundus of the stomach, extending along the posterior wall and on the lesser curvature side. The clinical impression was that of carcinoma with probable metastasis. A total gastrectomy was done. The spleen and distal half of the pancreas, into which the lesion had penetrated, were also removed. Pathological examination showed the lesion to be a huge peptic ulcer without evidence of malignancy.

The findings in these patients illustrate the difficulties in diagnosis and in deciding the extent of operative procedures to be done.—*D. S. Kellogg, M.D.*

Boyd, David P., and Hill, Lucius D., III. Benign tumors of the esophagus. *Ann. Surg.*, March, 1954, *139*, 312–324.

The authors state that benign tumors of the esophagus are both uncommon and interesting. Their review of the literature indicates that up to the report of their 15 cases there have been only 51 surgically treated cases reported. The addition of their cases brings the total of surgically treated cases to 64 at the time of the publication of their article. Of their 15 cases, 9 were leiomyomas, the most common benign lesion of the esophagus. Five of their 9 cases of leiomyomas had no symptoms referable to the esophagus. The lesions were found on routine examination.

Esophageal cysts occurring in the thorax are described under many names. These include duplications of the alimentary tract, gastroenteric cysts, etc. When no attachment to the esophagus exists, such cysts have usually been classified as mediastinal cysts. The origin of these cysts has been the subject of considerable discussion in the literature. It has been concluded that they have been pinched off as nodules during fetal development of the gut. The authors report 2 cases of esophageal cysts which were removed surgically.

The third group of tumors consisted of two fibromas of the esophagus. These are apparently the first two fibromas to be successfully removed surgically.

An extensive hemangioma of the upper two-thirds of the esophagus is presented. The patient has had five episodes of bleeding over a period of twenty years. No specific treatment was recommended for this patient.

In addition to the cases already mentioned, one patient with a large polyp in the upper esophagus is discussed. This patient regurgitated the polyp into the back of the pharynx and was unable to re-swallow it. He finally pushed it into the esophagus manually. The polyp was removed with a snare and a coagulating current. The patient had a satisfactory postoperative course with no evidence of return of the polyp.

Fifteen cases of benign tumors are presented and 14 of these were successfully operated upon without a single fatality.—*R. E. Kinzer, M.D.*

Abdomen

Sharp, George S., and Hazlet, John W. Evaluation of a new method for supplementation of gastric hydrochloric acid. *Am. J. Digest. Dis.*, May ,1954, *21*, 140–144.

A new hydrochloric acid preparation, "Normacid," produced by Stuart Company of Pasadena, California is discussed. This oral medication, the authors found, gradually disintegrates in the stomach releasing hydrochloric acid over a time interval comparable to the physiologic release of hydrochloric acid by the normal stomach. The tablet contains betaine hydrochloride 440 mg., methyl cellulose 110 mg., and pepsin 32.4 mg.

When using this medication, many of the side effects experienced with hydrochloric acid drops or

gelatin capsules are avoided. Transient nausea in some of the patients with previously prolonged achlorhydria was the only side effect encountered with this medication.

Many functional digestive complaints and dietary intolerances have been symtomatically relieved in the achlorhydric patient. The improvement in the oral symptoms is encouraging.

The authors also emphasize the value of the cation-exchange-indicator-quinine (CEIQ) urine test for estimating the free hydrochloric acid production of the stomach. They feel that this clinical test would be extremely valuable in detecting the achlorhydric patient in mass screening surveys.—*Fay H. Squire, M.D.*

Lijla, Bengt. Gastric motive function; with particular reference to the activity of the conducting system in the stomach. *Acta radiol.*, March, 1954, *41*, 225–246.

Observations of gastric motivity in patients with lesser curvature ulcers, and severe ulceration in or near the incisura angularis has led to the suggestion that there are separate motive centers for the vertical and transverse portions of the stomach, and that the motive center for the transverse stomach is situated at the incisura angularis. In severe ulceration at the angularis the function of this center is abolished, resulting in arrhythmia of the normally continuous motive cooperation between the parts, interrupted at the incisura. This is termed gastric block. A permanent contraction of the canalis (pyloric antrum) often appears in these cases.

The innermost muscle layer of the stomach, described by Forssell as a suspensory sling, is composed of oblique fibers extending from fundus to the incisura angularis, along the anterior and posterior aspects of the lesser curvature. The fibers fan out laterally and are intimately related to the circular muscle layer. Some of the fibers are inserted in the submucosa.

Contraction of the inner oblique muscular layer thus can cause shortening of the lesser curvature, local inward bulging of the greater curvature and a radial folding or spreading in the form of a fan from the ulcer, corresponding to the distribution of the inner muscle layer, and also the "gastritis picture" of increased serrations of the greater curvature. This increased folding may be caused by contraction and shortening of the wall, plus a participation of the mucosa through the activity of its muscularis mucosae (insertion of some of the fibers of the inner oblique layer into muscularis mucosa).

This ascribes to a common cause, *i.e.*, spastic contraction of the inner muscular layer, the triad of roentgenologic signs of ulcer of the lesser curvature: (1) inward bulging of the greater curvature with constriction of lumen, (2) folding radiating from the ulcer and (3) increased gastritis-like serrations of the contour of the greater curvature.

These signs of ulcer may persist after the ulcer has healed. However, better appreciation of their significance has led to more careful search and recognition of an increased number of ulcers, particularly those high on the lesser curvature.—*Lois Cowan Collins, M.D.*

Finby, Nathaniel, and Eisenbud, Mark. Carcinoma of the proximal third of the stomach; a critical study of roentgenographic observations in sixty-two cases. *J.A.M.A.*, April 3, 1954, *154*, 1155–1160.

There is a voluminous literature on the roentgenologic diagnosis of carcinoma of the stomach. Much of this deals with proper technique of the examination and special procedures. The authors have attacked the problem in a somewhat unique manner. They have attempted to analyze the accuracy of diagnosis of lesions in specific parts of the stomach. In order to do this they have examined the reports rendered on gastrointestinal roentgen examinations performed at the New York Hospital in the years 1947 through 1952 on patients subsequently proved to have carcinoma of the stomach.

They divided the cases into two groups. One group consisted of those in which the lesion was confined to the proximal third of the stomach and the second group of those in which there was involvement of the distal two-thirds of the stomach. In the series of 269 cases of carcinoma a lesion was detected in 96 per cent and was correctly diagnosed as carcinoma in 80 per cent. In the lesions of the proximal third of the stomach 13 per cent of the cases were missed completely while in the lesions of the lower two-thirds of the stomach only 2 per cent were missed. This makes it readily apparent that it is more difficult to demonstrate and correctly diagnose lesions in the proximal third of the stomach. In this particular series, 25 per cent of the lesions showed involvement confined to the proximal third of the stomach, which is considerably higher than the usually quoted 10 per cent.

The authors point out that the principal interfering factors in proper diagnosis of carcinoma of the proximal third of the stomach are a cascade configuration of the stomach and a hiatus hernia. In the 8 missed cases, 6 had a cascade type stomach and 1 had a hiatus hernia. In the 9 erroneously diagnosed lesions in the proximal third of the stomach, 5 had a cascade type stomach and 2 had a hiatus hernia. Three of these 9 cases were given a diagnosis of lymphosarcoma or leiomyosarcoma.

The authors conclude that the difference between accuracy of diagnosis of lesions in the proximal third and the distal two-thirds of the stomach is striking. It is readily apparent that diagnosis of proximal third gastric lesions is much more difficult and that special procedures might well be undertaken by any examiner to attempt to improve his diagnostic abil-

ity with reference to this portion of the stomach.—*R. E. Kinzer, M.D.*

FRIMANN-DAHL, JOHAN, LIND, JOHN, and WEGELIUS, CARL. Roentgen investigations of the nec-natal gaseous content of the intestinal tract. *Acta radiol.*, March, 1954, *41*, 256–268.

Serial roentgenograms of normal newborn infants taken at 1, 15, 30, and 45 minutes and 1, 2, and 3 hours after birth showed partial expansion of the lungs and a small air-bubble in the stomach at the first examination; full expansion of the lungs and a larger air-bubble in the stomach at 15 minutes; gas in the duodenum and jejunum at 30 minutes, well into the ileum at 1 hour, in the terminal ileum and often in the cecum at 2 hours, and throughout the intestinal tract in 3 hours. The degree and rate of distention were not influenced by crying.

The rate of progress of swallowed air is sufficiently constant to permit a rough estimate of duration of life in full term, well formed infants. In the premature, maldeveloped, and feeble, the rate of progress is slowed and too irregular to estimate duration of life.

Roentgenograms of stillborn infants showed no gas in the gastrointestinal tract. The demonstration of a gastric air-bubble may be accepted as proof of life. The usefulness of these observations in forensic medicine is self-evident.—*George Cooper, Jr., M.D.*

WILSON, HUGH E., DESFORGES, GERARD, DUNPHY, HERBERT G., and CAMPBELL, ALEXANDER J. A. Volvulus of the cecum; emphasis on possible predisposing lesions of the left colon. *A.M.A. Arch. Surg.*, May, 1954, *68*, 593–604.

The authors state that next to an awareness of this condition as a clinical entity and a relatively rare cause of intestinal obstruction, roentgenologic studies are the greatest single aid in the diagnosis. The criteria for diagnosis on flat and upright survey films of the abdomen are:

(1) Cecum greatly dilated and appears to lie in an ectopic position.
(2) Loops of small bowel may be seen distended with gas and often lying to the right of the distended cecum.
(3) The ileocecal valve may be demonstrated lying to the right of the distended cecum.
(4) The spiral distortion of the mucous membrane may sometimes be seen at the site of twisting, being visible because of contrast with gas in the bowel.
(5) There is usually a considerable dilatation of the small bowel with fluid levels in the upright position, suggestive of small bowel obstruction.
(6) Usually there is a single fluid level in the distended colon. (In volvulus of the sigmoid there is usually no distention of the small bowel and two fluid levels in the distended loop can be seen in most instances.)

The case histories of 8 patients, all females, aged forty-six to ninety-two years, are presented in detail with their respective survey films illustrated. Four of the 8 patients had co-existing left colon pathology which the authors believe was the predisposing factor leading to the cecal volvulus. On this basis, they recommend that in any case of volvulus of the cecum, the left colon be investigated after the acute problem has been remedied.—*William H. Smith, M.D.*

GERSHON-COHEN, J., and KREMENS, VICTOR. X-ray studies of the ileocecal valve in ileocecal tuberculosis. *Radiology*, Feb., 1954, *62*, 251–254.

The ileocecal valve is a focal point of particular interest in ileocecal tuberculosis since most of the lesions are centered about this structure. The authors have found the double contrast colon examination a useful method of studying the cecal side of the valve.

The changes found in tuberculosis of the ileocecal valve consist of irritability and spasm in the early stages, and rigidity and impaired motor activity in the later stages. Distortions of the lips of the valve when found in a patient with pulmonary tuberculosis, in the presence of shortening and contraction of the cecum or other roentgenographic signs of ileocecal tuberculosis, are almost certainly due to disease.—*Donald N. Dysart, M.D.*

BRUWER, ANDRÉ, BARGEN, J. ARNOLD, and KIERLAND, ROBERT R. Surface pigmentation and generalized intestinal polyposis (Peutz-Jeghers syndrome). *Proc. Staff Meet., Mayo Clin.*, March 24, 1954, *29*, 168–171.

The authors report the occurrence of multiple benign adenomatous polyps in the stomach, duodenum, small intestine and colon of a twenty-seven year old woman who exhibited pigmentation changes in the lower lip. Two brothers had been operated on for polyps, and two other brothers were said to have symptoms of stomach trouble.

The syndrome of small dark brown or black spots of pigmentation on the lips, external nares, mucous membranes of the cheeks, gums, and palate associated with multiple familial intestinal polyposis was first described by Peutz and later by Jeghers and associates. Less than 30 proved cases have been reported.—*J. A. Campbell, M.D.*

SHAPIRO, ROBERT. Cholecystography; a critical review. *Radiology*, Feb., 1954, *62*, 245–247.

The physiology of the normal gallbladder is reviewed with a discussion of the various factors which may result in poor or non-visualization. Factors contributing to poor or non-visualization are:

1. Failure of the patient to ingest or retain the contrast substance
2. Delayed gastric emptying
   (a) Pyloroduodenal obstruction
   (b) Psychogenic factors resulting in prolonged pylorospasm
3. Failure of absorption of the medium
   (a) Diarrhea
   (b) Pancreatic disease
   (c) Primary disease of the small intestine
4. Impairment of hepatic function
5. Too rapid emptying of the gallbladder, *e.g.*, hyperchlorhydria
6. Physiological stasis
7. Drug effect
8. Previous cholecystectomy
9. Cystic duct stone
10. Severe disease of the gallbladder mucosa preventing adequate concentration of the medium
11. Lactation.—*Everett E. Seedorf, M.D.*

Jacobson, George, and Heitmann, Kenneth A. Cholangiography with a viscous, water-soluble contrast medium (diodrast in methylcellulose). *Radiology*, Feb., 1954, *62*, 241–244.

Although diodrast in methylcellulose has been found not entirely satisfactory for bronchography, it is an ideal contrast medium for cholangiography. A mixture of 25 per cent diodrast and 1 per cent methylcellulose produces the optimum density and viscosity. No reactions to the medium have been observed.

Some of the advantages of the mixture are summarized as follows:

1. It forms a continuous column, being miscible with bile, and there is none of the disturbing globule formation seen so frequently with oily media.

2. The density is such as to permit adequate fluoroscopic visualization and the obtaining of excellent roentgenograms, yet not so great that small radiolucent calculi contained in a large dilated common bile duct are obscured.

Cholangiograms obtained with this medium are reproduced.—*Everett E. Seedorf, M.D.*

Leger, Lucien, and Proux, Charles. Les enseignements de la spléno-portographie. (Experiences with splenoportography.) *Presse méd.*, March 24, 1954, *62*, 469–472).

The technique, said to be harmless by surgical proof and autopsy, includes: (1) conjunctival drop test for compatibility of contrast medium; (2) premedication with barbiturates; (3) local procaine anesthesia; (4) intercostal (infracostal in splenomegaly) puncture of spleen with thick spinal needle (10/18 mm.) under fluoroscopic guidance; (5) proof of correct location by (a) bloody return, spontaneously or after injection of procaine, (b) respiratory needle movements, and/or (c) injection of few cubic centimeters of contrast medium, supposed to pool around needle tip; (6) very fast injection of 20 cc. diodone (organic iodine compound) 70 per cent; (7) roentgenograms made every second with seriograph or camera device.

The "normal" splenoportogram visualizes (a) the spleen, either by interstitial diffusion, by subcapsular penetration, or by outline of the splenic bed, (b) the splenic vein, its confluence with (c) the portal vein, and the latter's ramifications in the right lobe, seldom in the left lobe of the liver.

Under pathologic conditions, there may be (1) obstruction to portal flow. Fairly easy to interpret are venous obstacles, such as (a) portal phlebitis (with proved case of acute portal thrombosis), (b) operative interruption of the portal vein, and (c) compression (the authors cite a proved case of inflammatory hyperplasia of head of pancreas) or thrombosis of splenic vein. Parenchymatous obstacles, *i.e.*, cirrhosis of the liver, give controversial aspects, because the degree of opacification depends on the speed and pressure of injection, and on the timing of exposure. The procedure is also useful in (2) hepatic tumors, (3) various splenomegalies, (4) to establish patency of portal flow, and (5) for surgical purposes, for instance preoperatively in portal hypertension, or to demonstrate a successful portocaval shunt.—*E. R. N. Grigg, M.D.*

Gynecology and Obstetrics

Weens, H. Stephen, Clements, J. Luther, and Tolan, John H. Radiation dosage to the female genital tract during fluoroscopic procedures. *Radiology*, May, 1954, *62*, 745–749.

Employing midget ionization chambers in the vaginal fornices, the amount of radiation received by the mid pelvis during fluoroscopic and other abdominal diagnostic procedures was measured. The results showed that the radiation received by the female mid pelvis during barium enema studies was less than 1 r, with exposure during upper gastrointestinal studies considerably lower. It was found that one-third to one-half of the exposure during colon studies was due to the taking of large abdominal roentgenograms.

Phantom studies were also carried out, and it was concluded that in fluoroscopic examination high surface values do not necessarily reflect correspondingly high dosage rates in the mid pelvis. However, the surface dosages can be considerably reduced by proper filtration, with corresponding reduction of dosages within the body, without significantly affecting dosages at the position of the fluoroscopic screen.

The need for more accurate information on the effect of radiation on human mutation rates and fetal development is discussed. The authors feel that fetal irradiation during fluoroscopy is much lower

than estimated by previous investigators, but believe that until more definite determinations are made, it is wise to keep radiation to pelvic structures at a minimum. The fetus is probably most radiosensitive between the second and sixth week of gestation. —*C. L. Stevenson, M.D.*

HULTBERG, SVEN. Pregnancy in Hodgkin's disease. *Acta radiol.*, March, 1954, *41*, 277–289.

Two papers have appeared in recent Scandinavian literature advocating induced abortion in cases of pregnant women with Hodgkin's disease. At the Radiumhemmet in Stockholm, 13 of 100 fertile women have become pregnant while suffering from Hodgkin's disease.

Detailed case histories are given for all women and they indicate that pregnancy, parturition and puerperium run a normal course. There was no evidence of exacerbation during pregnancy. Four of the patients said they never felt so well as they did during the pregnancy.

There is no conclusive proof that Hodgkin's disease may be transmitted from mother to child. The great majority of children are healthy, the oldest in this group now being fifteen years of age.

Eight of the patients are alive and in good health, eight to fifteen years after the onset of the disease. None died in connection with pregnancy or within a year after delivery.

From this experience as well as a review of over 100 cases in the literature, the author considers that there is seldom any indication for interruption of pregnancy in patients with Hodgkin's disease.—*David C Gastineau, M.D.*

KALTREIDER, D. FRANK. The contracted outlet. *J.A.M.A.*, March 6, 1954, *154*, 824–827.

Clinically it has been impossible to determine whether a difficult delivery in the low pelvis was due to disproportion in the midplane, the outlet, or both. Therefore the interspinous diameter was tested. The interspinous diameter of the midplane is a much more desirable measure than the outlet sum, but not quite so definite as the anteroposterior, although quite satisfactory. The critical diameter may be considered to be the 9 cm. level. This suggests that in many instances when it was felt that the obstruction was at the outlet, the actual disproportion was at least in some way concerned with the midplane.

This analysis has left these impressions. First, the use of the roentgenographic anteroposterior diameter will give a better yardstick to measure outlet contraction than the usually accepted criterion of the sum of the intertuberous and posterior sagittal diameters. Second, for practical clinical purposes, the midplane and the outlet should be considered as one plane. Certainly from an anatomic viewpoint these two planes can be separated easily.—*Eugene J. McDonald, M.D.*

WEINBERG, ARTHUR. Radiological estimation of pelvic expansion. *J.A.M.A.*, March 6, 1954, *154*, 822–823.

It has long been recognized that the usual obstetrical patient will deliver her second and third babies with greater ease and with shorter labor than her first. This is true even though customarily the birth weight of each succeeding child shows a slight increase over that of its predecessor. The decrease in dystocia in each succeeding delivery has in the past been attributed to the dilatation and lacerations of the soft parts of the birth canal, the lower uterine segment, cervix, vagina, and perineum. On this basis one would expect all multiparous deliveries, without positional dystocia, to be easier, provided the contractions are efficient and the increase in the size of the baby not excessive. However, an appreciable percentage of primiparous and multiparous second stage labors resemble each other closely. It is therefore necessary to consider that other factors may be responsible for inconsistent prognostications of multiparous deliveries.

The question of whether the true bony pelvis undergoes significant expansion before or during labor is certainly more important than how much molding a head can safely undergo, since pelvic expansion is always safe whereas molding may be dangerous. By studying 171 pregnant patients who had roentgen pelvimetry by the same technique ten days before term of two or more pregnancies, it has been possible to estimate the degree and frequency of pelvic expansion during pregnancy and labor and to estimate its clinical significance.

Transverse or coronal expansion of the pelvic inlet has been demonstrated in the great majority of pregnancies and to a significant degree in about one-third of the cases. The expansion occurred mostly during pregnancy, but also to some extent during labor and delivery.

The study showed that the degree of expansion is not dependent on the age of the patient, the weight of the baby, or the difficulty of delivery. The only factor which was significant was that the incidence and degree of expansion were more pronounced in primiparas than in multiparas. The pelvic expansion was permanent, except when it was accompanied by pathological symphyseal spread, in which case coronal contraction occurred simultaneously with the reduction of the separation of the symphysis in the late puerperium.—*Eugene J. McDonald, M.D.*

GENITOURINARY SYSTEM

SPENCE, HARRY M. Anomalies and complications of the urogenital tract associated with congenital imperforate anus. *J. Urol.*, April, 1954, *71*, 453–463.

A major urological disorder was found in 15 of 44 patients with congenital imperforate anus. In 10 pa-

tients there was evidence of faulty embryology, 3 had coincidental urinary tract anomaly and in 2 patients the urological disturbances were a result of operative accident at the time of surgical correction of the original condition.

The characteristic genitourinary anomaly associated with imperforate anus consists of some form of abnormal communication between the lower intestinal and genitourinary tracts. Depending upon the location of the fistula and the sex of the individual the patient may exhibit (1) a rectovesical fistula, (2) a recto-urethral fistula or (3) some variety of persistent cloaca. The first two types occur predominantly in males, the third type is more common among females. Roentgen demonstration of the fistulous tracts and the condition of the upper urinary tracts are important prior to surgery. Individual surgical procedures are aimed at completely separating the urinary and intestinal tracts.

Fourteen illustrations include roentgenographic reproductions, anatomical drawings and photographs of the anatomy or specimen demonstrating these lesions.—*George W. Chamberlin, M.D.*

Pendergrass, Eugene P., and Brooks, Frank P. Report of a case of osteonephropathy with vascular calcification in infancy. *Radiology*, Feb., 1954, *62*, 227–233.

Fourteen cases of osteonephropathy (renal rickets), in combination with vascular calcification in young persons, have been collected from the literature. An additional case is presented in detail. The ages of the patients varied from four weeks to twenty-one years. All showed severe renal disease with azotemia, and the majority displayed acidosis, anemia, and hyperphosphatemia. All patients showed roentgen changes in the long bones.

The roentgen changes may be indistinguishable from those seen in ordinary rickets; or they may be characterized by swelling of the epiphysis, trabecular thickening, subperiosteal erosion, and moth-eaten ("woolly") metaphyses. In the skulls of 9 cases the 14 "woolly" changes resembling Paget's disease or hyperparathyroidism, with multiple round areas of increased density or a granular osteoporosis, were evident.

The least common roentgen finding is arterial calcification. In addition, calcification of non-arterial soft tissues occurred in 12 patients. On examination of the urinary tract, polycystic kidney, calculi, or nephrocalcinosis may be found. When examined at necropsy, most of the parathyroid glands exhibited secondary hyperplasia. The case presented showed characteristics of both rickets and scurvy early in treatment. After three months of treatment, calcification in the arteries of the extremities and possibly of the splenic artery was noted.—*William A. Goodrich, Jr., M.D.*

Davidson, Charles N., Dennis, John M., McNinch, Eugene R., Willson, James K. V., and Brown, Webster H. Nephrocalcinosis associated with sarcoidosis; a presentation and discussion of seven cases. *Radiology*, Feb., 1954, *62*, 203–214.

The authors present 7 cases of sarcoidosis with nephrocalcinosis. Other soft tissue calcifications were present in 2 of the cases. Pulmonary changes varied from a minimal infiltrate to a fibrosis and definite miliary calcinosis. Adenopathy was present in 2 cases. All of these cases, and the majority reviewed in the literature, showed hypercalcemia, although hypercalcemia is not necessarily accompanied by nephrocalcinosis. The soft tissue calcifications present in association with sarcoidosis occur both in the sarcoid lesions and as metastatic foci in normal tissue.

There appears to be no definite correlation between the hypercalcemia and bony involvement.

It is advised that patients with nephrocalcinosis should be thoroughly investigated for sarcoidosis.—*Everett E. Seedorf, M.D.*

Mortensen, JD, and Emmett, John L. Nephrocalcinosis: a collective and clinicopathologic study. *J. Urol.*, April, 1954, *71*, 398–406.

Summary and Conclusions: Considering as nephrocalcinosis only that diffuse renal parenchymal calcification which is demonstrable roentgenographically, the authors have collected from the medical literature 48 cases and from the files of the Mayo Clinic 43 cases of this disorder. Analysis of data derived from study of these 91 collected cases of nephrocalcinosis has led them to make the following observations concerning this lesion:

The underlying primary disorder responsible for the development of nephrocalcinosis is recognizable clinically in approximately 84 per cent of the cases. Three disorders, namely, primary hyperparathyroidism, hyperchloremic acidosis and chronic pyelonephritis, are responsible for 75 per cent of the cases of nephrocalcinosis. Less common etiologic disorders are chronic glomerulonephritis, recurrent "idiopathic" renal lithiasis and "idiopathic" hypercalciuria.

There are no characteristic symptoms or physical findings attributable to nephrocalcinosis, and its clinical recognition depends on its roentgenographic demonstration.

Adequate clinical evaluation of the patient with nephrocalcinosis includes determination of concentration in blood of calcium, phosphorus, carbon dioxide combining power, chlorides and urea or nonprotein nitrogen. Proper interpretation of the results of these laboratory determinations usually indicates the nature of the primary disorder responsible for the nephrocalcinosis.

Pathologic findings in patients with nephrocalcinosis include deposits of calcium primarily in medullary regions in relation to collecting tubules, and chronic inflammatory changes in medullary interstitial tissues. Degenerative changes, including large areas of destruction, replacement with calcareous deposits, cystic dilatation and deformity of tubules, and cicatrization, are common findings in kidneys with nephrocalcinosis. However, none of these gross or histologic findings are pathognomonic of roentgenographically demonstrable nephrocalcinosis and any or all may be present in kidneys which do not cast roentgenographic shadows which can be interpreted as nephrocalcinosis.

Early recognition and prompt eradication of the primary causative disorder before advanced renal insufficiency has developed appear to offer patients with nephrocalcinosis the best chance for postponing or avoiding fatal uremia.—*George W. Chamberlin, M.D.*

MORTENSEN, JD, BAGGENSTOSS, ARCHIE H., POWER, MARSCHELLE H., and PUGH, DAVID G. Roentgenographic demonstration of histologically identifiable renal calcification. *Radiology*, May, 1954, *62*, 703–712.

The postmortem kidneys of 210 patients were studied for histologically identifiable calcification of the renal parenchyma. It was found that parenchymal calcification commonly exists in the kidneys to a degree, extent or type that is not demonstrable roentgenographically.

Disorders in which renal calcification was demonstrated roentgenographically include primary hyperparathyroidism, chronic glomerulonephritis and chronic pyelonephritis.

Renal calcification identifiable histologically, but not roentgenographically was demonstrated in such disorders as hypochloremic alkalosis accompanying chronic duodenal ulcer, osteolytic lesions of various types, vitamin D intoxication and renal insufficiency secondary to a variety of organic renal lesions.

Quantitative chemical determinations generally demonstrate a higher content of calcium in those kidneys in which there was roentgenographic evidence of calcification.

It is suggested that the term "nephrocalcinosis" should be reserved for the type of renal calcification which can be shown roentgenographically, while the term "renal parenchymal calcification" should refer to that which is identifiable only by histological examination.—*Everett E. Seedorf, M.D.*

SWARTZ, DAVID. Renal papillary necrosis. *J. Urol.*, April, 1954, *71*, 385–397.

Renal papillary necrosis is an ischemic necrosis involving primarily the renal papilla. It can be diagnosed by clinical, pathological and roentgenological findings. While the disease is most commonly associated with pyelonephritis it may also occur as a primary vascular lesion independent of pyelonephritis or as an isolated lesion with no demonstrable vascular occlusion or infection. It may be seen in diabetic patients with or without predisposing factors of urinary stasis or in non-diabetic patients most of whom exhibit some degree of obstruction in the urinary tract.

The bacteria most commonly found in this condition are *Escherichia coli* but others such as *Staphylococcus aureus*, Friedländer's bacillus, *Bacillus proteus*, alpha and beta streptococci and *Pseudomonas aeruginosa* may also occur.

The roentgen pyelographic findings are a moth-eaten appearance of the minor calyces resulting from necrosis and sloughing of the renal papilla with non-opaque defects within the contrast filled pelvis due to blood or debris.

The differential diagnosis should include: (1) renal tuberculosis; (2) pyelonephritis without papillary necrosis; (3) renal tumor with pelvic involvement and hemorrhage; (4) renal colic with non-opaque calculi.

In this article 3 cases of papillary necrosis are reported with illustrations of pyelographic and gross and microscopic pathological changes.—*George W. Chamberlin, M.D.*

SHEACH, J. N. Enuresis in children; the value of radiological investigation. *Proc. Roy. Soc. Med.*, May, 1954, *47*, 348–350.

Enuresis is defined as a state in which normal micturition occurs without the patient's knowledge.

Of 276 children between two and fifteen years undergoing urographic examination at the Bristol Children's Hospital, 164, or 59.4 per cent, were investigated because of enuresis. Of these, 108 were boys and 56 were girls. All children had retrograde pyelography which included a post-micturition film to show residual urine.

Eighty-eight of these were normal. Twenty-five had developmental anomalies which included a solitary right kidney, a horseshoe kidney, an ectopic kidney and several cases of duplex kidney. One of these had a second ureter emptying into the external urethral meatus.

Thirty-three had trabeculation of the bladder which was taken as evidence of bladder disease. Six cases had cystitis and 18 had bladder neck hypertrophy, the presenting symptom of which is frequently enuresis.

Twenty-three had definite residual urine. This was significant only in children over five years of age after two attempts at micturition. In 10 cases it was associated with bladder neck hypertrophy.

Three children had severe renal lesions, 1 having a ureterocele with unilateral hydronephrosis, 1 renal tuberculosis and 1 chronic pyelonephritis with recurrent cystitis.

The author feels that excretory urography plays an important part in the investigation of enuresis. Of all cases examined, 70 to 75 per cent will probably be normal, 20 to 25 per cent will probably show or suggest bladder neck hypertrophy, and 1 to 2 per cent may show more serious conditions or developmental defects causing the enuresis.—*William C. MacCarty, Jr., M.D.*

Friedman, Paul S., Solis-Cohen, Leon, and Joffe, Samuel M. Urethral calculus: its roentgen evaluation. *Radiology*, Feb., 1954, *62*, 248–250.

Urethral calculi are not uncommon. They are of two major types, primary and secondary. The former originate in the urethra while the latter migrate to the urethra from elsewhere in the urinary tract.

Poorly draining intra-urethral and para-urethral cavities, the sequelae of prostatic and peri-urethral abscesses, postgonorrheal urethral glandular infection and congenital or acquired diverticula which result in urinary stagnation and infection enhance the formation of primary calculi. They are often single but may be multiple when in a diverticulum and are usually composed of calcium phosphate. Urethral strictures are not a prerequisite and do not necessarily predispose to their formation. They are often asymptomatic for a long period.

Secondary calculi, much more frequent in males, are almost always single, and usually contain a nucleus of uric acid and calcium oxalate.

The authors present a case report of a man with a large urethral calculus measuring 4.2 by 3.0 by 2.5 cm. in size. Roentgenograms showed its subpubic location in the midline. Urethrography demonstrated its position in relation to the urethra. Surgical removal resulted in relief.—*Donald N. Dysart, M.D.*

Bunge, R. G. Further observations with delayed cystograms. *J. Urol.*, April, 1954, *71*, 427–434.

Technique: The bladder is slowly filled but not overdistended by a warm solution of 10 per cent skiodan. The catheter is withdrawn and a film exposed immediately. The patient is instructed to retain the fluid and films are exposed at intervals of thirty minutes for one hour.

Results: Among 24 normal children and adults ranging from nine months to seventy-four years of age ureteral reflux was not demonstrated in any of the examinations.

Ureteral reflux occurred in 8 of 36 patients with neurologic bladder. In these 8 cases the residual urine ranged from 30 to 250 ml.

Among 28 patients with bladder neck obstruction, ranging in age from twenty months to eighty-five years, ureteral reflux was seen in 6 children and 3 adults. In 3 of the 6 children reflux did not appear on the initial cystogram but was detected on subsequent delayed cystograms.

In 24 full term pregnant women ureteral reflux did not occur in any instance.

Twenty-three patients with urological disease in whom ureteral reflux would not ordinarily be suspected were examined. Five adults and 4 children showed ureteral reflux.

Summary: Ureteral reflux is rare in normal individuals. It is more likely to occur in children with vesical neck obstruction and may be a factor in persistent pyuria even after the vesical obstruction has been removed. Two cases of "automotive" pyelitis are briefly discussed.—*George W. Chamberlin, M.D.*

Boijsen, Erik, and Lewis-Jonsson, Johannes. Emphysematous cystitis. *Acta radiol.*, March, 1954, *41*, 269–276.

To quote the authors, "Our present knowledge of the etiology and pathogenesis of emphysematous cystitis may be summarized by saying that it is brought about primarily by bacteria belonging to the colon group, that diabetes mellitus promotes its occurrence and that it appears to be a condition of cystitis rather than a disease sui generis."

The diagnosis may be established at cystoscopy or by roentgen examination. Three stages in the evolution of the condition can be distinguished, and the roentgen findings are different in each stage.

Stage 1: Gas production commences in the bladder wall. On roentgen examination the gas appears as a clear zone about 1 mm. wide around the contrast medium in the bladder.

Stage 2: Gas production in the bladder wall is more advanced. Individual vesicles can now be distinguished in great numbers. The lumen of the bladder is reduced, and the wall is irregularly thickened.

Stage 3: Rupture of the intramural vesicles reduces the amount of gas in the wall and releases it into the bladder. The bladder wall returns to normal thickness and the bladder lumen to normal size.

A case of emphysematous cystitis in a diabetic female is reported, and roentgenograms of all stages are reproduced.—*George Cooper, Jr., M.D.*

Hinman, Frank, Jr., Miller, Gerald M., Nickel, Eldon, and Miller, Earl R. Vesical physiology demonstrated by cinéradiography and serial roentgenography; preliminary report. *Radiology*, May, 1954, *62*, 713–719.

The authors report the results of studies of vesical physiology in normal female subjects. Cineradiology and serial roentgenography were employed to produce sequence cystograms during voiding. With the roentgen movies they were able to make exposures at the rate of 3.25 frames per second; with the Fairchild roll-film cassette, the time between films was 1.1 sec-

onds. Two hundred cubic centimeters of 7 per cent sodium iodide and 25 per cent skiodan (or of 25 per cent skiodan alone) were injected by cathether into normal nulliparous women. Serial exposures were made during the entire time of emptying the bladder.

The results of their studies have caused the authors to question some of the current concepts of the mechanism of urination. Urination, while coordinated, appears to be made up of several semi-isolated components, which may act independently. They observed the following sequence in nulliparous female subjects:

(1) Isometric detrusor contraction and opening of internal sphincter; (2) relaxation of perineal muscles; (3) emptying contraction of detrusor; (4) isolated closure of external sphincter; (5) contraction of perineal muscles with elevation of base of bladder, (6) closure of internal sphincter and relaxation of detrusor.

The use of the techniques described for the study of the normal and diseased bladder in the male and female patient should aid our understanding of vesical physiopathology.—*Arno W. Sommer, M.D.*

DeWeerd, James H. Lipomatous retroperitoneal tumors: urographic findings. *J. Urol.*, April, 1954, *71*, 421–426.

Preoperative diagnosis of retroperitoneal lipomatous tumors is both difficult and unusual. Symptoms, as a rule, are minimal, a common complaint being gradual unexplained enlargement of the abdomen. Sometimes the palpable mass is a finding incidental to routine physical examination. Urinary symptoms are conspicuous by their absence.

This article is a discussion centered around a review of 31 cases of known retroperitoneal fatty tumor. In 5 instances a survey film only was recorded and did not contribute to the diagnosis. Twenty-six cases had excretory or retrograde pyelograms. In 13 of these, there was renal displacement, often associated with some degree of torsion, without distortion of the collecting system. There was distortion of the collecting system in 3 instances; displacement of the ureter in 3; a visible soft tissue mass was contiguous to the kidney in 2 patients, and the pyelographic findings were negative in 5 cases.—*George W. Chamberlin, M.D.*

Nervous System

Jacobs, Lewis G., Smith, James K., and Van Horn, Phillip S. Myelographic demonstration of cysts of spinal membranes. *Radiology*, Feb., 1954, *62*, 215–221.

This article gives 2 case reports of cysts projecting from the subarachnoid space which were filled with opaque medium at myelography. One was a congenital extradural meningeal cyst and the other a perineurial cyst.

Routine roentgenograms of the spine may show in the extradural meningeal cyst only slight widening of the spinal canal in either diameter or erosion of the pedicles. The usual myelographic finding is that of a partial or complete block and the cyst will not be seen unless it communicates with the subarachnoid space. These cysts arise by a gradual ballooning out of the meningeal membranes from a point of congenital weakness near the root exit zone.

Perineurial cysts are thought to arise from a splitting of the nerve root coverings, possibly on the basis of inflammatory changes, with eventual distention of the potential space between the endoneurium and the perineurium to form a true cyst. Routine roentgenograms usually show negative findings and myelograms almost always fail to fill the cysts. Absence of signs of disc herniation on the myelogram is an important differential point since the clinical picture of the two conditions is identical.—*Donald N. Dysart, M.D.*

Heiser, Saul, and Swyer, Alfred J., Myelography in spinal metastases. *Radiology*, May, 1954, *62*, 695–702.

The authors reviewed 75 cases of tumors involving the spinal canal which had been studied by myelography; 27 per cent of them were metastatic cancer and 8 per cent were lymphoma.

Mechanisms explaining the occurrence of metastatic lesion in the epidural space of the spinal canal are described under the following: (1) hematogenous spread, (2) vertebral vein system dissemination, (3) extension from adjacent osseous structures, (4) direct extension via the intervertebral foramina, and (5) primary growth of lymphoma within the spinal canal.

The usual symptoms and signs produced by pressure on the epidural structures are considered. Osseous metastases were seen in 12 of the 20 cases with metastatic cancer and coincided with the level of cord compression in 10 instances. The interpediculate measurement was generally not useful in diagnosis.

The myelographic filling defects varied considerably. They depended upon the degree of obstruction produced by the tumor, the configuration of the neoplasm, the relationship of the mass to the cord or cauda equina, and the status of the supporting osseous structures. In most instances a complete block was demonstrated. In the cervicodorsal region there was usually a smooth concave margin of the contrast medium while in the lumbar region the obstruction was usually more abrupt with dentate margins. Figures illustrate these changes.

There is usually no difficulty in differentiating from intramedullary tumors. Intradural, extramedullary tumors are generally more abruptly and sharply demarcated because of the absence of intervening dura between the dura and contrast agent.

Metastatic lesions producing only partial block give filling defects which are unilateral, broad,

smooth, sweeping indentations sometimes extending over several vertebral segments.—*Everett E. Seedorf, M.D.*

Skeletal System

Coleman, E. N., and Foote, J. B. Craniostenosis with familial vitamin-D-resistant rickets. *Brit. M. J.*, March 6, 1954, *1*, 561–562.

The authors report the case of a boy aged six years with vitamin D resistant rickets who also suffered from scaphocephaly due to premature closure of the sagittal suture.

Only one previous case with this association has been discussed in the literature although it has evidently been present in other reported cases, and has been mistaken for a purely rachitic phenomenon.—*Arthur E. Childe, M.D.*

Goldfarb, Arthur A., and Ford, Douglas. Osteogenesis imperfecta congenita in consecutive siblings. *J. Pediat.*, March, 1954, *44*, 264–268.

The authors report the occurrence of the congenital type of osteogenesis imperfecta in consecutive siblings of the same parents, representing the second and third offspring. Both infants followed the same clinical course with death occurring after the onset of an intercurrent respiratory infection which failed to respond to therapy. The first sibling died at the age of 5½ months and the second at the age of 5 months.

The congenital type of osteogenesis imperfecta usually does not exhibit a familial tendency. The striking clinical feature is a softness of the cranial vault with subsequent deformities in the temporal and occipital regions. Multiple fractures may occur at birth producing grotesque deformities of the trunk and extremities. Pseudojoints may be evident at the fracture sites. The patients rarely survive infancy.

Osteoporosis is the most important roentgen finding in this condition. Marked thinning of the cortex, diminution of the thickness of the shaft of the bone with some flaring toward the diaphysis, normal epiphyseal-metaphyseal relationship and coarsening of the trabeculation are the characteristic features. Callus formation in varying stages may be present about the fracture sites. Ossification centers are normal. In one case, the long bones were broadened.

The exact mechanism for the development of osteogenesis imperfecta is not clear. The lack of lamellar bone formation and the presence of pathological fiber bone may account for the defect in mesenchymal tissue which is postulated as the fundamental pathology of this condition.—*James F. Martin, M.D.*

Liess, G. Die Nebenkernbildung bei der normalen und gestörten Epiphysenossifikation und ihre Beziehung zu den aseptischen Nekrosen. (The formation of accessory ossification centers in the normal and disturbed ossification of the epiphysis and its relationship to the aseptic necroses.) *Fortschr. a. d. Ceb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Feb., 1954, *80*, 153–165.

Aseptic necroses do not represent an individual disease but are caused by many different factors such as trauma, embolism or inflammatory processes. For the greater number a so-called insufficiency damage is the best conjecture.

The formation of accessory ossification centers is one of the factors which may lead to aseptic necroses. Its relationship to aseptic necroses is practically important and theoretically interesting since accessory ossification centers may simulate aseptic necroses, or aseptic necroses may develop on the basis of the formation of accessory ossification centers.

The author gives the history and the roentgenographic findings of 3 cases which show accessory ossification centers. These cases and those which he found in the literature prove that on certain epiphyses and at a certain age formation of accessory ossification centers is normal, otherwise it represents an abnormal process of the epiphysis. Different factors may account etiologically for the deviation from normal. These are, as confirmed by author's cases, either inflammatory processes and hormonal disturbances, or a congenital disturbance of the formation of the epiphysis.

The author concludes that there is a twofold relationship to the aseptic necroses and that aseptic necroses may be simulated by "fragmented" epiphyses. They may develop in constitutionally weak epiphyses, the "weakness" being due to a disturbed ossification with formation of accessory ossification centers.—*Hans Lewin, M.D.*

Souders, Carlton R., and Manuell, J. Lawrence. Skeletal deformities in hyperparathyroidism; report of a case. *New England J. Med.*, April 8, 1954, *250*, 594–597.

This is a case report of a twenty-nine year old woman with a five year history of vague joint pains, progressive deformity of the thorax, swelling of the tips of the fingers and fracture of several bones following slight trauma. A cyst of the mandible had been removed and was diagnosed as a "giant cell tumor."

Roentgenographically there was severe osteoporosis of all the bones with coarsening of the trabeculae. There were cysts in many bones. The hands showed severe subperiosteal resorption in the proximal and middle phalanges. The terminal phalanges were almost completely absorbed and there was clubbing of the soft tissues. There was complete resorption of the dental lamina dura. There

was collapse of three of the upper dorsal vertebrae. No renal calculi were seen.

Laboratory studies showed elevated serum calcium, lowered phosphorus, and elevated alkaline phosphatase and hypercalciuria. A moderate anemia was present. There was slight diminution of renal function.

The diagnosis of hyperparathyroidism was made and a parathyroid adenoma removed.

Following this, the patient had prompt symptomatic recovery and skeletal recalcification, but the severe deformities persisted.

Most of the skeletal changes seen here are those usually associated with hyperparathyroidism. The subperiosteal resorption of the terminal phalanges is seen in this disease and in renal osteodystrophy. The explanation for the clubbing of the fingers is obscure, but may be related to the reduced vital capacity secondary to the severe skeletal deformity. It may represent rounding of the tissues resulting from loss of the skeletal support, or may be a specific soft tissue reaction to the bone disease. The anemia could have contributed to it.

The absence of renal calculi was probably explained by the low calcium intake of the patient.—*George L. Sackett, Jr., M.D.*

PALMER, J. D., and MACKAY, J. W. Hereditary deforming chondrodysplasia; report of an unusual case. *Brit. J. Surg.*, March, 1954, *41*, 462–466.

The authors present an interesting case of hereditary deforming chondrodysplasia in a young male whose major complaint was a huge exostosis arising from the left clavicle which endangered his life by tracheal obstruction. This mass on the clavicle had grown rapidly in the last four years although it had been present since childhood. A bone survey of this patient revealed multiple ecchondromas and enchondromas affecting most of the metaphyses of the long bones. The mass was removed and found to be a benign osteochondroma.

In the pathology of this condition the exostoses may number from one to one thousand. The ends of the long bones are primarily affected, the common sites being the femur and tibia in the region of the knee joint, the upper end of the fibula and the lower ends of the radius and ulna. The histogenesis is in dispute with one school considering that the abnormal processes consist of fragments of cartilage from the epiphyseal line, isolated on the surface of the metaphyses and proliferating to form exostoses. The second group holds that the periosteum is incomplete at the sites of these cartilaginous rests and fails to mold the metaphyses in a normal manner. A general survey of the literature reveals that malignant changes develop in 7 to 11 per cent.

The roentgen findings of hereditary deforming chondrodysplasia have three salient features: (1) formation of multiple exostoses of the pedicle or broad base type; (2) widening of the metaphyseal ends of the long bones; (3) deficient growth of the ulna or fibula with continued growth of the radius and ulna producing bowing of the radius or tibia. The differential diagnosis includes chondrodysplasia and metaphyseal dysostosis.—*Thomas D. Allison, M.D.*

THOMPSON, PAUL C. Subperiosteal giant-cell tumor; ossifying subperiosteal hematoma—aneurysmal bone cyst. *J. Bone & Joint Surg.*, April, 1954, *36-A*, 281–291.

The author uses in this paper a threefold title to bring together the ideas regarding a single entity which has been described in the literature under many apparently unrelated terms. This benign bone lesion characteristically occurs as a mass displacing or lying in soft tissues with its base attached to the shaft of a long bone. The mass is surrounded by a thin, dome-like shell of calcified bone enclosing cystic spaces which are filled with blood. The lining of the cystic spaces is a very cellular structure which may closely resemble a giant-cell tumor. Lesions involving vertebrae, flat bones and small bones of the hands and feet may be modified from this classical pattern by local anatomy which permits or prevents the typical development.

Most of the articles in the American literature refer to the lesion as a hematoma which is ossifying or calcifying. Bloodgood in 1910 recognized the condition and interpreted it as a bone cyst due to periosteal hematoma with formation of a bony shell about the hematoma. Cone in 1928 regarded the lesion as an ossifying subperiosteal hematoma resulting from trauma with various histological elements proliferating in the course of normal attempt at repair. During the 1930s and 1940s attention was focused on the microscopic aspects of the lesion and hence arose such terms as "subperiosteal giant-cell tumor" and "atypical giant-cell tumor," the former introduced by Geschickter and Copeland and the latter by Coley and Miller. In 1950, Lichtenstein recommended the term "aneurysmal bone cyst" to avoid the misunderstanding which a term suggesting a neoplastic process may produce. Lichtenstein, while rejecting the explanation of traumatic origin, agrees with the concept of vascular disturbance. He believes that the lesion originates within the bone and that the bony shell represents the "attenuated remnants of the original cortex."

The ability to recognize the somewhat unusual but characteristic features of the lesion is of practical importance and the description of these features was the purpose of the author in this paper. The tumor differs in many respects (age of the patients, location of the lesion, roentgenographic and microscopic appearance) from genuine giant-cell tumor and probably represents a reparative process following some as yet undetermined vascular disturbance about the

periosteum and surrounding tissues. It seems probable according to Thompson that such a growth might arise from rupture of a periosteal or nutrient vessel with subsequent seepage of blood and tumor formation. Such a hypothesis emphasizes the nonneoplastic nature of the disease and belies any convenient diagnostic term available. The origin of the lesion—that is whether it arises within or outside of bone—and the role played by trauma are still matters for discussion.

The roentgenographic features vary during the natural growth of the tumor. In its early development the lesion produces a soft tissue mass of increased density but without calcification or changes in the adjacent bone. The intermediate stage, during the third or fourth month of duration, shows gradual development of a domelike calcified shell outlining the periphery of the tumor. As time progresses, spontaneous healing may occur, with the mass becoming ossified.—*Ralph S. Bromer, M.D.*

Coley, Bradley L., and Higinbotham, Norman L. Secondary chondrosarcoma. *Ann. Surg.*, May, 1954, *139*, 547–559.

Secondary chondrosarcomas are malignant tumors having their origin in previously existing benign chondromas. Although the frequency of malignant degeneration is difficult to estimate, the authors believe that the incidence is significantly high to justify extreme watchfulness if not prophylactic removal. The enchondromas in the long bones, the bulky projecting osteochondromas with irregular calcifications and the chondromas in the bones of the pelvis are most apt to undergo malignant change.

In the authors' series of 52 cases the average age incidence was 38.9 years at the time of discovery of the secondary chondrosarcoma. The time for sarcomatous degeneration varied from eighteen months to thirty years.

Pain in a previously asymptomatic cartilaginous tumor, acceleration of growth, or suggestive changes in the roentgenogram are the most significant signs and symptoms of malignant degeneration. A biopsy report of benign chondroma should be held with suspicion when the above signs and symptoms are present and if surgical extirpation is not accomplished, frequent re-evaluation should be done.

Surgery is the only treatment for the secondary chondrosarcomas. The authors believe that removal of benign chondromas may in reality constitute cancer prevention. The prognosis is far more favorable than is the case in osteogenic sarcomas or in the primary chondrosarcomas. Metastases are prone to occur much later. Because of this fact, the authors believe that these secondary chondrosarcomas should be separated from the statistics of other bone sarcomas. It is also advocated that a ten year follow up would be a more significance than a five year study when considering prognostic implications.

A final plea is made for more aggressive treatment of benign cartilaginous tumors and a prompt aggressive surgical treatment is advocated once the malignant phase has been recognized.—*Fay H. Squire, M.D.*

Campbell, Douglas J., and Doyle, J. Oliver. Tabetic Charcot's spine; report of eight cases. *Brit. M. J.*, May 1, 1954, *1*, 1018–1020.

The authors report the clinical findings in 8 cases having changes diagnosed as a tabetic Charcot's spine.

The most characteristic feature of Charcot's spine is the disproportion between the severity of the process disclosed by the roentgenogram and the slight discomfort and disability complained of by the patient.

The process is usually limited to one or two segments of the spine with marked deformity and little or no tenderness or muscle spasm. It is claimed that roentgenologically the alternation between sclerosis and rarefaction, bone absorption and bone apposition, is the most striking feature in Charcot's spine. In some cases the destructive, in others the proliferative, changes prevail.—*V. L. Peterson, M.D.*

Leitner, Baldo. Obstacles to reduction in subtalar dislocations. *J. Bone & Joint Surg.*, April, 1954, *36-A*, 299–306.

In this paper obstacles to reduction in subtalar dislocations are discussed. In 3 of 4 cases of medial dislocation, open reduction was necessary because of the nature of the dislocation. In 2 of these it was undertaken because of impaction of the navicular in the fractured head of the talus and in 1 because of impaction of the ligamentum cruciatum cruris. In the fourth case, however, reduction by the open method was necessary because of an accompanying subluxation of the talus, around which the tendons of the musculi peronei were twisted.

Only 1 of 5 lateral dislocations was irreducible at first because of the position of the tendon of the tibialis posterior, but even this was reduced by the method described by Böhler. In this case, increase in length of the tendon was about 3 cm. The increase in length apparently came from that part of the tendon proximal to the injury site. The tendon was displaced mediolaterally from its normal groove at the distal end of the tibia and passed diagonally over the distal end of the tibial shaft. That part of the tendon which inserted into the navicular and medial cuneiform was carried laterally with the dislocation, with the result that the tendon slipped laterally over the head of the talus. It then passed from the plantar surface of the navicular dorsally over the joint cavity of that bone, lateral to the neck of the talus, and from there diagonally to the medial side of the distal end of the tibia.

The paper is illustrated with roentgenographic reproductions and anatomical drawings of the dislocations.—*Ralph S. Bromer, M.D.*

STEWART, MARCUS J., and MILFORD, LEE W. Fracture-dislocation of the hip; an end-result study. *J. Bone & Joint Surg.*, April, 1954, *36-A*, 315–342.

This paper deals with the treatment of fracture-dislocation of the hip, the complications, and the end results in a series of 193 patients with an adequate follow-up of 128.

In their comment and conclusions the authors state that dislocation of the hip is an emergency demanding immediate reduction. Manipulative reduction should take precedence over treatment of all other skeletal injuries and even abdominal injuries. Open reduction of the acetabulum may be delayed provided the dislocation of the femoral head has been reduced. Postoperative immobilization is necessary only to maintain stability. If fractures are stable, there is no indication for prolonged restriction of weight-bearing. Early, active, and vigorous exercise to restore muscle function and to prevent degeneration of the articular cartilage is a major feature of therapy. Early exercise does not tend to promote the deposition of calcium or the development of myositis ossificans. The age of the patient has little influence upon the end result.

The differential diagnosis between avascular necrosis and degenerative arthritis as complications is often difficult. Transitory or permanent increase in density or cystic changes in the head and neck of the femur are undoubtedly due to vascular disturbances. Such changes may logically be called avascular necrosis or sclerosis. The authors attempt to draw a distinction between arthritis and avascular necrosis, basing their diagnosis of avascular necrosis upon the presence of infarction in the femoral head. Avascular necrosis is the result of disruption of the blood supply to the femoral head and is possibly the result of intracellular molecular changes in the femoral head incidental to force and counterforce imposed at the time of injury. The average rate of development of avascular necrosis is the same, regardless of the method of treatment. Arthritis develops in direct proportion to the severity of the fracture and the extent of vascular damage.

Injuries of the sciatic nerve warrant exploration if their effects persist for two weeks without improvement.—*Ralph S. Bromer, M.D.*

THIEMEYER, JOHN S., JR. Monarticular coccidioidal arthritis; report of a case with apparent cure following synovectomy. *J. Bone & Joint Surg.*, April, 1954, *36-A*, 387–390.

Involvement of joints can occur in the acute or in the chronic granulomatous stage of coccidioidal infection. The disease produces a primary mild pulmonary involvement often diagnosed as "flu." During the disseminated or secondary phase, signs of acute arthritis develop in about a third of the patients. This may appear simultaneously with erythema nodosum. It is the chronic granulomatous phase which may be the forerunner of disseminated disease which will lead to death. Survival is the rule for the acute phase, but the mortality is high in the granulomatous phase.

In the case reported in this paper, the patient had acquired the infection when he was in army training in an endemic area. The secondary granulomatous stage of the condition became apparent in the right knee and during the next several years the disease in the joint pursued an indolent but progressive course, until it finally became disabling. The roentgen examination after synovectomy showed a slight narrowing of the joint interspace but no significant abnormality could be visualized. While synovectomy is a departure from the usual treatment of arthrodesis or amputation, the author believes that it may be considered in selected future cases of monarticular coccidioidomycosis as an effective and nondeforming procedure.—*Ralph S. Bromer, M.D.*

COPLAND, WILLIAM A. Bone changes in diabetes. *Proc. Roy. Soc. Med.*, May, 1954, *47*, 345–347.

Jordan, in 1936, first drew attention to the coexistence of Charcot joints and peripheral neuritis in diabetes. Since then 68 cases have been presented and several authors have expressed the opinion that these are true neuropathies independent of impaired blood supply.

The author examined roentgenographically the metatarsals and phalanges of all patients from the Diabetic Clinic of the Bristol Royal Infirmary who had symptoms or signs referable to their feet, either absent reflexes, diminished sensation, gangrene, absent pulses or ulcers. Fifty patients were examined of 400 patients attending the clinic and 19 of these showed bone changes.

None had the classical features of a Charcot joint. It was found that all of the patients showing bone changes had an inflammatory lesion presently or previously near the site of the affected bone which was thought to be the direct cause of the bone changes.

Osteoporosis is the first bone change followed by a break in the cortex, usually in the neck of the phalanx or metatarsal. Then an osteitis ensues. If healing occurs at this point, there is a periosteal reaction and bone repair. If not, the head of the bone is gradually destroyed followed by the shaft and medulla. The edges of the bone approximate each other giving a tapered appearance. The process may be arrested at any stage which is not the case in neuropathic joints.

Although there is no reason why a Charcot joint should not develop in a diabetic with neuritis, it is

considered that the vast majority of the bone changes commonly seen in this condition although influenced by poor blood supply, lack of sensation and possibly by the abnormal metabolism of diabetes are due to an inflammatory process.—*William C. MacCarty, Jr., M.D.*

BRAIN, RUSSELL. Spondylosis; the known and the unknown. *Lancet*, April 3, 1954, *1*, 687–693.

The author's interest is primarily concerned with the effects of the disk degeneration upon the nervous system.

The changes are grouped under the term "spondylosis," which implies that the lesions are degenerative and not inflammatory. Sometimes the term "herniation" of the intervertebral disk is used and sometimes the term "protrusion." It is widely believed that the two are synonymous.

A distinction is suggested between two main types of intervertebral disk protrusion—(1) nuclear herniation and (2) annular protrusion.

Nuclear herniation probably starts with swelling of the nucleus. The annulus, which is encroached upon by the expanding nucleus, undergoes fibrillary degeneration. Its inner fibers emerge with the nucleus while its outer fibers disintegrate. As the result the nuclear material may be extruded into one or other intervertebral foramen, or more dorsally.

The production of an annular protrusion is different. Owing to various factors, of which age is probably the most important, the intervertebral disk becomes dehydrated and loses its elasticity. As a result it collapses and the annulus bulges in all directions. The protruded material becomes vascularized and its fibrous elements are increased in the same manner as in the nuclear herniation. Similarly, the added tissue increases the size of the original protrusion, and again calcification or ossification may occur.

The impairment of their normal functions leads to reactive changes in the bodies of the adjacent vertebrae. These are stimulated to new bone formation—*i.e.*, the production of the osteophytes which tend to fuse with the disk protrusions. Furthermore, the collapse of a disk also results in subluxation of the corresponding intervertebral joints with secondary osteophyte formation on the articular processes, which leads to further narrowing of the intervertebral foramina.

In the late stages it is not possible to distinguish the one type from the other by means of roentgenographic study.

Problems of Etiology. In this series of cases of cervical spondylosis two-thirds of the patients gave no history of trauma. Only 6 out of 45 gave a history of injury which could possibly have contributed to the causation of the disorder. Undoubtedly, the most important causal factor is the biochemical change in the intervertebral disks which occurs with ageing and is associated with a loss of water.

The mechanism of root compression depends not only upon the size and location of the protrusion but also upon the angulation of the radicular nerve and its situation in the foramen. At the same time the narrowing of the disk throws an additional strain upon the corresponding intervertebral joints and that leads to secondary osteophyte formation on the articular processes, thus narrowing the foramen posterolaterally. The chronic constriction of the nerve roots and radicular nerve, and associated ischemia, lead in time to the degeneration of the nerve fibers.

In the *roentgenological investigation* of a patient suspected of cervical spondylosis it is usually necessary to make exposures in three lateral views (in the erect, flexed, and extended positions) as well as in an anteroposterior view and in right and left oblique views to show the intervertebral foramina. Without the flexed and extended lateral views it may be impossible to detect spondylolisthesis. In addition, plain roentgenograms may show a narrowed intervertebral disk space, indicating disk degeneration; posterior osteophytes, in the manifestation of which especially soft tissue exposures may be helpful; and osteophytic invasion of the intervertebral foramina.

Some Radicular Syndromes of Cervical Spondylosis. The author believes that the various clinical pictures described in the past as "brachial neuritis" or "brachial neuralgia" are in most cases the result of the pathological changes described as root-sleeve fibrosis.

The pain of radicular distribution due to cervical spondylosis and referred to the shoulder is not infrequently followed by the condition known as "frozen shoulder" in which gross limitation of active and passive movements of the shoulder occurs and any attempt to move the joint causes pain. The possibility that a "frozen shoulder" is a symptom of cervical spondylosis should be considered.

To add to the hazards of diagnosis, not only may cervical spondylosis coexist with an independent lesion of the nervous system but it may sometimes be associated with other abnormalities of the spine or of the spinal cord—particularly of congenital origin, such as congenital fusion of vertebrae, cervical spina bifida, and the Arnold-Chiari malformation. Syringomyelia and tabes may also cause a cervical arthropathy which may be actually complicated by spondylosis.

Thoracic intervertebral disk protrusions are certainly far less common than disk protrusions at the cervical and lumbar regions, presumably for mechanical reasons.

The same distinction between nuclear and annular protrusions discussed in connection with cervical disks applies also to the lumbar region. Certain points of difference are noted between the two. In the lumbar region acute nuclear protrusions are a much commoner cause of symptoms than in the

cervical region. In the lumbar region pre-existing disk degeneration is a more important predisposing cause of such nuclear protrusion than it is in the neck. Plain roentgenograms may provide no clue as to whether a narrowed lumbar intervertebral disk space is the result of simple disk degeneration, annular protrusion, or nuclear protrusion.

Lumbar foraminal pressure-radiculitis increases in frequency with age, and is most commonly encountered in the seventh and eighth decades. It is, however, especially common in diabetics. It may be uniradicular or multiradicular and unilateral or bilateral. Pain is usually less severe than in sciatica resulting from disk protrusion and is less likely to be exacerbated by coughing or sneezing. It is often, however, influenced by posture and may be worse when the patient is sitting. When several roots are involved there may be conspicuous muscular weakness and wasting associated with fasciculation, and diminution or loss of the knee-jerks.—*Stephen N. Tager, M.D.*

Hallock, Halford, and Jones, James B. Tuberculosis of the spine; an end-result study of the effects of the spine-fusion operation in a large number of patients. *J. Bone & Joint Surg.*, April, 1954, *36-A*, 219–240.

This is a very voluminous paper based on a study of 192 patients with tuberculosis of the spine who were operated upon. A few had undergone previous spine-fusion operations but active disease was still present (either in a second focus or as a progression of the disease in the original focus), and there was failure of arthrodesis or the fusion was found to include too few vertebrae.

In the analysis of cases the treatment, complications, subsequent spine fusions, pseudarthrosis, paraplegia and the end-results are discussed in detail.

The authors arrive at the following conclusions:

1. Spine fusion is a safe and effective means of obtaining long-standing clinical and roentgenographic subsidence of disease in a large percentage of patients. The results are somewhat better in children.

2. To be most efficacious spine fusion should be performed early in the course of the disease, before the development of major abscesses or of paraplegia, but it is still of great value and should not be withheld even after such complications have developed.

3. Failures are due to pseudarthroses or inadequate areas of fusion and also may occur in instances of marked virulence of the infecting organism or in overwhelming disease in individuals with low resistance.

4. Tuberculosis is a general disease of which the spine lesion is a local manifestation. This fact should not be overlooked in the treatment of the individual. Streptomycin and the newer isonicotinic acid hydrazides appear to have a beneficial effect on the disease itself, and also are of great value in the treatment of the local lesion and its complications of sinuses and abscess formation.

The article is illustrated with roentgenographic reproductions of some of the cases.—*Ralph S. Bromer, M.D.*

Bauer, William H., and Harell, Alex. Myxoma of bone. *J. Bone & Joint Surg.*, April, 1954, *36-A*, 263–266.

This report is based on the microscopic findings in an expanding tumor of bone which on the basis of clinical findings was suspected of being malignant, but which proved to be benign. The roentgenogram of the lesion showed a sharply outlined area of bone destruction, 4 by 6 cm., on the medial aspect of the left femur at the distal metaphyseal end. The lesion had expanded the cortical contour and was internally bordered by a thin sclerosed layer of bone. A limited area of the expanded cortex showed erosion which led several roentgenologists to consider the lesion "as very probably malignant." A biopsy was performed and the patient was operated upon and serial roentgenograms, the last eight months after operation, showed that healing was progressing well. Chest roentgenograms demonstrated no abnormal changes.

The microscopical findings as reported fulfilled Stout's criteria for "myxoma." The mucoid material in the tumor sections was of connective tissue origin, as proved by staining. As regards the argyrophil fibers, the authors agree with previous writers that these elements should be called "silver-staining fibrils," in order to avoid the controversy whether they are precollagenous fibers or reticulin fibers. The amount of fibrosis in the tumor was not such as to warrant a diagnosis of myxofibroma. No cartilaginous or bony elements were found. However, the small collagenous and fibrous areas indicated a slight tendency toward higher differentiation. This trend, according to the authors, supports the view that occasionally a myxoma may locally show chondroid and fibrous tissue and so become a chondromyxoid fibroma. Neoplasms of primitive mesenchymal tissue may locally differentiate into cartilage and bone.

The authors conclude that the nature of the myxoma reported in the paper, the healing process and the present excellent health of the boy confirm Stout's statement that myxoma is a benign neoplasm. Stout's opinion that there are no histopathological criteria to distinguish between myxoma and myxosarcoma was not shared by Sponsel and his associates who stressed the greater vascularity, perivascular accumulation of cells, and variety of silver-staining fibrils in myxosarcoma of the soft tis sue.—*Ralph S. Bromer, M.D*

Garceau, George J., and Gregory, Charles F. Solitary unicameral bone cyst. *J. Bone & Joint Surg.*, April, 1954, *36-A*, 267–280.

The material for this report was obtained from a clinical study of 27 cases and a review of the literature. The greatest incidence, the authors found, was between the ages of nine and fourteen years. The condition occurred in males twice as often as in females. The long bones were almost invariably involved but the calcaneus was also frequently affected.

Since the basic pathological process is one of bone resorption, the authors state that it is most likely to be associated with remodeling which had got out of control. Beyond this speculation as to etiology, no theory of cyst origin has ever been effectively sustained.

The uncomplicated bone cyst usually presents a dearth of clinical signs and symptoms. Unless a fracture has taken place, a dull, often intermittent and usually a mild pain or ache in the area involved is the only complaint. The roentgenographic examination reveals the first sign of the cyst. Roentgenograms show the following features:

1. Evident destruction of medullary bone;
2. Destruction of bone on the inner side of the cortex;
3. Subperiosteal new-bone formation on the inner side of the cortex;
4. An expansile defect in the metaphysis;
5. Trabeculated lines in the wall of the cyst causing the appearance of multiloculation;
6. A thin dense cyst wall may separate the cyst from the medullary cavity of the bone which is an indication that the lesion is old.

Serial roentgenograms will show the cyst being pushed away from the epiphysis and will reveal any change in the size of the cyst. The cyst frequently is found to abut directly against the epiphyseal plate but rarely projects across it. Jaffe and Lichtenstein are quoted who have considered this relationship to imply a state of activity and have designated the cyst so situated as one in the "active" phase. The counterpart of this state is the so-called "latent" phase which is said to be present when an interval of normal bone is found lying between the epiphyseal plate and the cyst. The active phase of the cyst is construed to be that state in which the cyst is enlarging, while in the latent phase the cyst remains quiescent and the epiphyseal plate migrates away from it.

The gross and microscopic changes are described in detail in the paper. The cavity of the cyst is incompletely occupied by a variable amount of yellowish fluid; it may be red or hemorrhagic if there has been recent trauma.

The differential diagnosis is usually not difficult. Some of the lesions which should be considered are fibrous dysplasia, non-osteogenic fibroma, giant-cell tumor, enchondroma, osteitis fibrosa cystica resulting from hyperparathyroidism, neurofibroma and lipoma.

Fracture is the most common complication. The question whether a cyst is obliterated in the course of healing of a fracture has received a great deal of consideration. The authors noted that if the cyst is in the active stage, it may actually enlarge and be associated with another fracture later.

Essentially three basic forms of treatment have been employed, roentgen therapy, transplantations of autogenous or homogenous bone grafts, and total resection of the cyst area. The authors state that roentgen therapy usually fails to effect obliteration of the cyst. The technique of curettage combined with some form of bone-grafting has given the most consistently satisfactory results. Tables are included in the paper giving end-results obtained in the authors' cases and in cases reported in the literature. Roentgenographic reproductions showing results of serial examinations are also included.—*Ralph S. Bromer, M.D.*

Ghormley, Ralph K., and Romness, Joseph O. Pigmented villonodular synovitis (xanthomatosis) of the hip joint. *Proc. Staff Meet., Mayo Clin.*, March 24, 1954, *29*, 171–180.

The term "pigmented villonodular synovitis," introduced by Jaffe, Lichtenstein and Sutro, has come to be recognized as designating a widely diffuse xanthomatosis involving the synovial membranes of the joints and tendon sheaths. It is primarily a descriptive term for the fresh gross appearance as seen when the involved joint is opened surgically.

The most frequently involved joint in the body is the knee. Xanthomatous tumors have also been reported involving the ankle, foot, hand, elbow and temporomandibular joints as well as the hip joints. The authors report 4 additional cases with proved hip involvement. The roentgenographic findings in these cases consisted of narrowing of the joint space with cystic arthritic changes in the acetabulum and adjacent femoral head. The osteolytic cyst-like changes in the acetabulum are said to be characteristic.

Clinically, these patients showed progressive pain and limitation of hip motion for two to nine years. Involvement in every case was monarticular.

From the standpoint of pathology, the lesion has been considered to be of a benign inflammatory nature by most workers. The authors are of the opinion that these tumors should be classified under the heading of the primary essential xanthomatoses and that they should be called xanthomas of the tendon sheaths and synovial membranes.—*J. A. Campbell, M.D.*

Blood and Lymph System

Keizer, D. P. R., and Rochat, R. R. Malignant reticuloendotheliosis (Letterer-Siwe dis-

ease); report of case with normocholesteremic lipid granulomatosis and eosinophilic granuloma. *A.M.A. Am. J. Dis. Child.*, March, 1954, *87*, 328–336.

This case report is that of a girl aged seventeen months who suffered from malignant reticuloendotheliosis with normocholesteremic lipid granulomatosis and eosinophilic granuloma. During the course of the disease, roentgen examination showed destruction of the right scapula by multiple cysts. The whole bone seemed enlarged, but the shoulder joint remained intact. In other bones, no cysts or destruction could be detected but the lung showed a pseudomiliary appearance.

Treatment with antibiotics, corticotropin (ACTH) and roentgen irradiation of the scapula did not change the malignant prognosis. The child died showing symptoms of orthopnea, severe cyanosis, and hypertrophy of the right heart due to the loss of alveolar structure in the lungs.—*Ralph S. Bromer, M.D.*

Berenstein, Pedro. Síndrome de Leriche: Trombosis crónica aortoiliaca; contribución radiológica. (Syndrome of Leriche: chronic thrombosis of the common iliacs; roentgenologic contribution.) *Prensa méd. argent.*, March 26, 1954, *41*, 84c–844.

Leriche's syndrome consists of a localized arteritis below the bifurcation of the abdominal aorta in one of the common iliac vessels from 2 to 3 cm. from its origin. Subjectively, it causes intermittent claudication of one or both lower extremities, sensation of cold and marked diminution in sexual potency.

Aortograms are made by injecting the abdominal aorta through a translumbar route. When the disease causes a partial occlusion, there is a narrowing of the vessel. Below the narrowed segment the caliber of the vessel is normal. When the occlusion is complete, the opaque column is interrupted in a truncated cone. Recanalization of the thrombus does not significantly improve the circulation.

As Leriche's syndrome progresses, aortography provides a means of ascertaining the exact position of the lesion. Nine cases studied in this manner are presented.—*Murray M. Friedman, M.D.*

Shumacker, Harris B., Jr., Moore, Thomas, C., and Campbell, J. A. Functional venography of the lower extremities. *Surg., Cynec. & Obst.*, March, 1954, *98*, 257–272.

Early work in venography was primarily directed toward studies in the horizontal position to demonstrate patency of major venous channels. In an effort to evaluate venous function as well as anatomy, retrograde venography with the extremity in a state of quiet dependency was conceived.

The initial suggestion to use muscular activity to supplement information gained by retrograde venography was made at the authors' institution, and since 1949 investigations have been carried out to evaluate various techniques of functional venography in symptomatic and control patients.

In normal subjects, after injection of radiopaque material into the femoral or popliteal veins, opacification of the venous channels distal to the site of injection of varying degrees was found. After exercise, all showed complete or nearly complete emptying. After injection into superficial veins opacification of deep and superficial venous systems occurred with evidence of proximal propulsion of the contrast medium in both systems with exercise. It was felt by the authors that regurgitation in quiet dependency is not pathologic.

When injections were made into superficial varicose veins, the "contrast material drifted downward, and most, if not all of it" was returned proximally in the deep circulation.

When functional femoral or popliteal studies were done following deep venous occlusion, the popliteal vein was found to be patent in all with varying degrees of re-canalization of the popliteal-femoral veins. Valves could not be recognized and, frequently, numerous collateral veins were visualized in the thigh. On exercise all veins including those recanalized cleared indicating that all were able to participate in proximal propulsion of blood, though perhaps not as effectively as in normal subjects. It was felt, therefore, that there was no real indication for ligation.

No case of "idiopathic regurgitation" of a pathologic nature was found.

Functional venographic studies with lymphatic obstruction were useful primarily in excluding venous pathology.—*George A. Miller, M.D.*

General

Gallager, H. Stephen, Stayman, Joseph W., Jr., and Barba, Philip S. Inclusion disease of infancy; case report. *J. Thoracic Surg.*, March, 1954, *27*, 222–226.

Cytomegalic inclusion disease is a systemic disease, primarily of infants and very young children, characterized by intranuclear and intracytoplasmic inclusion bodies in gigantically enlarged cells of many organs. It is thought to be produced by the salivary gland virus. Since it may involve many organs including the liver, lungs, kidneys, brain and intestines, a variable clinical picture may be produced. In infants it is usually a fatal disease. According to the authors, no case of this disease has been reported heretofore in which the diagnosis was made during the patient's life.

A case is presented of a newborn white male infant who showed signs of pneumonia with cyanosis.

Later air-filled cysts developed in the site of the area of pneumonia and the clinical symptoms decreased. Because of progressive enlargement of the cysts, a thoracotomy was done and removal of the involved segments of lung accomplished. The patient's clinical condition improved markedly thereafter and he was discharged from the hospital.

Microscopic study of the specimen showed the histopathologic picture of cytomegalic inclusion disease. The involved cells lay largely within the lumina of the terminal bronchioles and possibly by a ball valve effect produced the lung cysts.

The authors comment that nonfatal cases probably occur but are not detected. The possibility that diseases such as fibrocystic disease of the pancreas may have some relationship to inclusion disease is suggested and reference is made to other cases of cytomegalic inclusion disease with associated fibrocystic disease.—*Paul C. Olfelt, M.D.*

Randall, Henry T. An evaluation of adrenalectomy in man: physiological changes and the effect on advanced neoplastic disease. Eighth James Ewing Memorial Lecture. *Bull. New York Acad. Med.*, April, 1954, *30*, 278–301.

The author reports on 20 patients with cancer of the breast, 17 patients with cancer of the prostate, and 9 patients with other type of cancer who have had bilateral adrenalectomy at Memorial Center, New York City.

Reference is made to the several studies made by other investigators along with their rationale and reported cases.

There was no response, subjective or objective, to bilateral adrenalectomy in any of the 9 patients having cancer other than of the breast or prostate. Objective response was limited to regression in size of the tumor masses by palpation or by roentgenologic examination.

Following bilateral adrenalectomy patients are maintained on oral cortisone alone in most instances and the androgenic effects of cortisone are discussed.

The 20 patients with cancer of the breast having metastases, with 1 exception, had undergone surgical castration at least six weeks prior to adrenalectomy. The 1 exception had received roentgen therapy with 2,000 r ovarian dose. Adrenalectomy was performed only when there was unequivocal evidence of progression of disease. Fourteen patients improved subjectively for two weeks to one year duration; 8 patients improved objectively; and, 1 patient had major regression of the metastatic disease, being asymptomatic one year later. The author feels that adrenalectomy may be an additional means of temporary control of advanced breast cancer, especially where there has been response to castration. The average response period was nine months.

Following adrenalectomy there was a sharp drop in urinary calcium excretion with markedly positive balance and also there was an increase in alkaline phosphatase consistent with increased osteoblastic activity. Also noted was regression of soft tissue metastases.

In 6 cases the disease progressed in spite of symptomatic improvement. All patients who responded to castration responded to adrenalectomy and the reverse was true as well, although this aspect is not discussed in detail.

The effect of cortisone on metastatic cancer and metabolism in the adrenalectomized patients is also considered.—*John F. Berry, M.D.*

Pyrah, L. N., and Smiddy, F. G. Mammary cancer treated by bilateral adrenalectomy. *Lancet*, May 22, 1954, *1*, 1041–1047.

After a review of the literature including both experimental and clinical work, in particular the work of Huggins and his associates, the authors report 22 cases of advanced mammary carcinoma, with metastases, submitted to bilateral adrenalectomy and bilateral oöphorectomy between April and December, 1953. They discuss in detail the management of these patients, the surgical technique, and substitution therapy both before, during, and after surgery.

Of the 22 patients, 1 died soon after the operation and 8 either died from cancer or showed no improvement. Ten patients showed improvement with major remissions in 5 and a probable major remission in another. The case histories of these 6 patients are presented in detail. Representative roentgenograms before and after surgery as well as before and after photographs illustrate the rather marked improvement that occurred in this group.

The authors state that their results confirm the work of Huggins and his co-workers that a favorable response sometimes follows bilateral adrenalectomy and bilateral oöphorectomy. Further observation of all the cases operated on in the present series and extension of the series will be necessary before any accurate long-term estimate of the effect of bilateral adrenalectomy can be made.—*William H. Smith, M.D.*

Strickland, Basil. Cushing's syndrome. *Proc. Roy. Soc. Med.*, May, 1954, *47*, 341–345.

Cushing's syndrome is due to an excessive formation of glucocorticoids by the adrenal cortex or a tumor of the adrenal cortex. It is characterized clinically by obesity, weakness and fatigue, sexual disturbances, greasy skin, acne, purple striae, hirsutism, pigmentation, hypertension and various other symptoms and signs.

Roentgenologically the two main features commonly described are osteoporosis and fractures. The osteoporosis is described as a constant finding and is thought to be due to a simple decalcification, al-

though some authors suggest that it is due to deficient formation of bone matrix. Fractures of the vertebral bodies are commonly reported in the literature but other sites are rarely mentioned.

The author contends that fractures are a more common feature of the disease than osteoporosis and are more widespread in the skeleton than has formerly been reported.

Five cases are presented, all 5 having rib fractures, 3 having fractures of the pubic rami, 2 vertebral fractures and 1 femoral neck fracture. Only 2 cases had definite osteoporosis. All fractures were characterized by abundant callous formation.

The author points out that while in Cushing's syndrome fractures are common and healing is good, in cortisone overdosage fractures are rare and healing is delayed (at least in animals).

The heart is often enlarged in Cushing's syndrome depending on the degree of hypertension. Enlargement of the pituitary fossa is rarely found as this is more characteristic of the adrenogenital syndrome.

In concluding, the author suggests that in Cushing's syndrome the radiologist survey the whole skeleton for fractures and osteoporosis, being diligent in his search for the former and being critical in his assessment of the latter. He should expect an enlarged heart and a normal pituitary fossa and should attempt to demonstrate an adrenal tumor by special examinations.—*William C. MacCarty, Jr., M.D.*

RADIATION THERAPY

Jamieson, H. D. A method of tumour localisation and field positioning in radiotherapy. *Radiology*, Feb., 1954, *62*, 195–197.

To overcome the problem of tumor localization in radiation therapy, the author has made use of a special rectangular caliper, together with anteroposterior and lateral roentgenograms.

From each roentgenogram, the maximum diameter and the distance along it to the tumor center are measured. By measuring the corresponding diameter on the patient, the roentgenographic measurement of the distance to the tumor center along the diameter may be corrected for magnification by simple proportion, and the caliper used to determine this point on the patient.

The caliper may be also used in conjunction with fixed bony reference points to determine precisely the position of a field in the treatment of a patient.—*A. Ralph Watson, M.D.*

Hare, Hugh F., Smedal, Magnus I., Johnston, David, Cote, Maurice, Trump, John G., Wright, Kenneth A., Granke, Richard, and Beique, René A. Observations on rotational therapy with two million volt roentgen rays. *J.A.M.A.*, March 13, 1954, *154*, 890–894.

During a three and one-half year period, at the Lahey Clinic and the Massachusetts Institute of Technology, over 500 patients have been treated with 2 million volt roentgen rays. This article is a summary of the techniques employed (especially rotational) and observations on biological responses.

The apparatus used is an electrostatic accelerator of the Van de Graaff type. The radiation quality is described as equivalent to that of cobalt 60 and radium, but the unit has a high output and an almost "point" source of emission. Radiation of this quality has the advantages of increased penetration, freedom from scatter, and increased skin tolerance. These advantages result in more adequate tumor dosage, less skin damage, and less radiation sickness.

Rotational techniques are particularly useful in the treatment of tumors of the brain, pituitary, pharynx, tongue, extensive involvement of cervical and supraclavicular nodes, thyroid, esophagus, bladder, cervix and extremities. It is preferable to use multiple port therapy in tumors of the nasopharynx, lung and lymphoid system, and other tumors requiring large fields and where radiosensitive regions must be protected.

Lymphoid tumors are given 2,400 r at depth in fifteen treatment days using multiple ports. Thyroid carcinomas are given 4,800 r rotationally to the entire neck and mediastinum in six weeks, a copper filter being used to equalize the dose over the neck and a posterior absorber being inserted to cut the dose to the spinal cord.

All epidermoid carcinomas receive a tumor dose of 6,000 r in seven weeks. This has not appeared to be sufficient in some bladder and cervical carcinomas, and at the present time 8,000 r is given to the primary tumor site in the same time. Rotational technique of the pelvis yields about 90 per cent of the central dose at the lateral pelvic walls; posterior shielding cuts the dose to the rectum, but all patients experience some diarrhea though little cystitis and no complications occur except in those previously irradiated.

Within the skull, pituitary and pineal tumors are especially suited for rotational therapy. Chromophobe and chromophile adenomas and pinealomas are given 4,000 r and basophile adenomas 5,000 r at the rate of 240 r per day through 3 to 4 cm. ports. This gives a rapid fall-off outside the maximum dosage area. Medulloblastomas are not treated rotationally, a dose of 2,400 r being given to the entire cerebrospinal system at the rate of 100–125 per day.

Nasopharyngeal tumors are also excluded from rotational therapy because it is thought desirable to treat all possible extensions. The aim is to deliver 6,000 r in seven weeks to the primary lesion and possible metastases. Opposing lateral fields to cover both the nasopharynx and neck and opposing anterior and posterior fields to include both the supraclavicular and mediastinal areas are used.

A scanning technique (not further described but referred to) delivers 6,000 r to the breast and surrounding lymphatic system, including the axillary, supraclavicular, and internal mammary lymph nodes and the neck. Little radiation reaches the lungs. A good erythema and subsequent tanning result.

Bronchogenic carcinoma is treated by opposing anterior and posterior ports to include the involved lung, the mediastinum, and the supraclavicular region. The tumor dose is 6,000 r in seven weeks, and, though it results in good palliation, in six months it leads to pneumonitis which in some cases is difficult to manage. The current technique is to give 3,000–4,000 r, remove the lung surgically, and then continue radiation therapy to 6,000 r. This technique is too new to evaluate.

A few osteogenic sarcomas have been treated rotationally. Dosage varied from 6,000–9,000 r in seven to ten weeks. It is the clinical impression that bone tolerates radiation of this quality much better than it tolerates conventional radiation.—*Henry J. Klos, M.D.*

Kligerman, Morton M., Rosen, Elaine G., and Quimby, Edith H. Rotation therapy technics applicable to standard deep-x-ray machines. *Radiology*, Feb., 1954, *62*, 183–194.

Rotational therapy equipment has been adapted to standard 250 kv. machines. As the patient is rotated on his vertical axis, the overlying tissue thickness varies markedly. Thus, the target-skin distance varies constantly, but the target-axis distance (usually 85 cm.) remains unchanged.

The planning and calculation method of the Massachusetts Institute of Technology is used. The tissue dose is described as the percentage of the "air dose at the axis of rotation" (*i.e.*, the dose at the axis if the patient were not present). Sets of dosage curves correlating varying tissue depths and distances from the rotational axis are constructed for certain field sizes. This is done by a formula calculating the absorption and scatter factors for given depths with a constant quality of irradiation. In the area of the *tumor only*, one may use midline depth dose table figures, rather than isodose curves, to construct the rotational therapy charts, since the tumor area is always in the center of the beam. The reader is referred to the excellent presentation of the original work for complete study of the formula, tables, and diagrams.

When these tables and curves have been obtained, one outlines the body contour and determines the dose to any point as follows: 12 radial lines are drawn to the axis, and the depth of tissue traversed by the beam between the skin and the specific point is measured along each line. The tissue dose of each line is determined from the dosage curves. The average value of the 12 lines gives the number of roentgens delivered to the point per 100 r in air at 85 cm. For doses outside the tumor area, simple correction factors will give accuracy within 10 per cent.

The lesion is located by roentgenograms and fluoroscopic study and outlined on the skin with silver nitrate, using two projections at right angles. Each mark is then aligned with the light beam localizer of the rotational unit, thus centering the axis on the tumor. Localizing roentgenograms are taken with the therapy machine for confirmation.

In the case of small central lesions (not exceeding 5 cm. in the skull, nor 10 cm. in the trunk) the axis of rotation is placed at the center of the tumor volume. The head is tipped backward or forward to avoid irradiating the eyes. In about five weeks 5,000 r is delivered to the central axis.

The maximum skin dose is always delivered to that point on the skin which is nearest to the axis of rotation. The minimum tumor dose is always on that portion of the tumor deepest below the skin, unless the axis of rotation is not centered on the tumor. In cases of small superficial eccentric lesions the rotational axis may be purposely shifted 1 to 2 cm. deep to the tumor center in order to improve homogeneity and give less skin dose on the superficial side.

With large superficial lesions, (greater than 5 cm. in the skull and 10 cm. in the trunk) large fields allow the skin to be longer in the beam. In these, a stationary port on the most superficial surface is used in combination with a "scanning" field opposite, moving in an arc of perhaps 120°.

A further refinement called *time-differential scanning* is used in large eccentric deep-seated lesions. Instead of rotation, two opposing areas are scanned in arcs, and the area farther from the tumor is treated for a longer time period.

In very irregular body cross-sections, bolus material may be added to make isodose curves valid. Lead strips and cut-outs may also be added in individual cases to protect vital organs.—*William A. Goodrich, Jr., M.D.*

Sharp, J., and Easson, E. C. Deep x-ray therapy in spondylitis. *Brit. M. J.*, March 13, 1954, *1*, 619–623.

The authors present 332 cases of spondylitis based on clinical and roentgenological study. These cases were divided into three groups: (a) "typical" cases which conformed to the clinical picture of ankylosing spondylitis; (b) "atypical" cases which were classed as such in the absence of satisfactory alternative diagnosis; and (c) borderline cases. In spite of the high incidence of the involvement of the hands and feet in the atypical group, the comparatively low proportion of patients in this group giving positive results with Ball's modification of Rose's serum differential agglutination test was considered as evidence that the atypical group was not largely composed of patients with rheumatoid arthritis affecting the spine.

Roentgen therapy was given to 275 of the 332 cases using 250 kv. with a half-value layer of 1.63 mm. of copper, with the focus-skin distance being 50 cm. Almost all of these patients were treated as outpatients with a dose of 150 r (measured with backscatter) being given to the skin surface of each field at each weekly visit for ten weeks. It was noted that the proportion of typical cases that were much improved after treatment was significantly higher than in the atypical group. In the typical group it was found that the best results were obtained in the patients whose symptoms were of five years' duration or less and in whom roentgenological changes were confined to the sacroiliac joint. The age or sex of the patient and the blood sedimentation rate gave no indication as to whether or not this patient would be improved after therapy. The authors recommend roentgen treatment only in cases in which the ankylosing spondylitis appears active as evidenced by pain in the area involved. It was found that significantly fewer patients were much improved after treatment when roentgenological changes were present in the spine or elsewhere then when changes were confined to the sacroiliac joint. No significant difference was observed in the behavior of the peripheral joints treated alone and those treated concurrently with the spine. This suggested that the effect of deep roentgen therapy in ankylosing spondylitis was a local one on the irradiated tissues.

The complications of roentgen therapy included: aplastic anemia in one case; reactivation of pulmonary tuberculosis in one case; permanent amenorrhea in 13 of the 47 females treated; and possible acceleration of renal failure in 2 cases.

The patients were encouraged to lead as normal lives as possible within the limits of their ability. Breathing exercises and measures to correct any deformity present were applied. Some of the patients with severe deformities were referred to surgery. Spinal supports were rarely advised and patients were confined to bed only under exceptional circumstances.

Since this study suggests that only patients suffering from typical ankylosing spondylitis benefit from roentgen therapy, it would seem necessary to have well defined criteria both from the clinical and roentgenological standpoint by which typical spondylitis could be distinguished from other conditions which may simulate this disease. Such a differential diagnosis is also desirable, since immobilization usually aggravates typical spondylitis, while it may be helpful in some of the atypical conditions.

Several tables, pictures and case histories are presented.—*Claude D. Baker, M.D.*

DAHL, OLOV. The treatment of plastic induration of the penis (Peyronie's disease). *Acta radiol.*, March, 1954, *41*, 290–301.

Comparison of results of prolonged treatment with vitamin E and radiation therapy of patients presenting themselves to the Radiumhemmet of Stockholm is given. Three hundred milligrams of mixed or synthetic tocopherols was given by mouth for at least six months to 18 patients. Four showed pronounced improvement, 6 moderate improvement and 8 no improvement. This should be compared with a series of 96 cases treated with radium or external roentgen therapy at the same institution. Nineteen of these showed pronounced improvement, 34 moderate improvement and the remaining 43 no improvement.

The radium treatment has been applied to superficial and circumscribed lesions. It consisted in the use of radium tubes, each containing 8 mg. placed in glass capsules which were fixed parallel to each other arranged in a roof-truss formation. Empirically an average dose of 1,100 r has been found to be adequate.

Roentgen therapy was given when the indurations involved the deeper tissues or were extensive. The skin dose was 1,200 r to one port or 750 r to two opposite ports, fractionated over three days, using roentgen rays of a half-value layer of 0.9 mm. Cu.

By protecting the scrotum with 4 mm. of lead and drawing it down to the anal region, the testicles received 10 r during the radium treatment and 0.02 r during the roentgen therapy.

The author concludes that it is advisable to start the treatment by irradiation and, unless pronounced improvement has occurred, institute vitamin E therapy later and continue it for at least four months. —*David C Gastineau, M.D.*

DI RIENZO, S. Radioterapeútica de las epiploitis. (Radiotherapy of epiploitis.) *Radiología*, Panamá, March, 1954, *4*, 51–54.

Nonspecific inflammatory process may occur in the epiploon which may be noted as an irregularity in the wall of the colon during barium enema studies. This may be caused in some instances by a foreign body imbedded in the body of the intestine. A perforated diverticulum in the region of the sigmoid may also set up a similar inflammatory process in that region. This inflammatory condition responds quickly and readily to roentgen irradiation.

Kilovoltage has varied from 80 to 180 kv. Filtration of 3 mm. aluminum up to 0.5 mm. of copper was used. In acute cases a dose of 35 to 50 r daily to a total of 600 to 800 r may be given. In the subacute cases a daily dose of 70 to 100 r, with total dose up to 1,500 or even to 2,000 r has been used. In females of the child bearing age an attempt was made to exclude the ovaries from the therapeutic field.—*Charles Nice, M.D.*